

WSDOT
Materials
Laboratory

2009

Annual Report

April 2010

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Introduction

State Materials Laboratory Mission Statement

“Together we support our customers and enhance construction quality by providing specialized technical expertise, materials testing, and engineering services.”

Welcome to our 2009 Annual Report. Our annual report was conceived as a method to convey three messages:

1. How we are measuring our performance, using internal customer performance measures
2. Informing our customers of what we do and what services we offer
3. Provide a road map to where we are headed in the future, especially with the Strategic Directions

We have expanded the Strategic Directions to provide greater detail on this important roadmap to the future. And check out the performance measures: we have driven up performance and driven down costs, especially in field exploration in the Geotechnical Division.

We appreciate any and all feedback.

On behalf of the great crew here at the State Materials Laboratory, I want to thank every customer for using our services and products in 2009; we look forward to serving you again in 2010.

Thanks,
Tom

Thomas E. Baker, P.E.
State Materials Engineer

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Strategic Directions 2009-2011

Construction Materials

Joe DeVol, Bituminous Materials Engineer

Examination of N-design: Nationwide research underway to validate the Superpave HMA design levels (compaction tables) for volumetric mix designs. The question is: are current standards giving us the best possible pavement performance?

This study to include: Review of WSDOT Equivalent Single Axle Loads (ESAL) and HMA design levels; Collect production data for comparison to mix design data; Identify candidate projects to evaluate pavement performance; Provide recommendations for future Superpave HMA design levels.

Status: Since implementation of the Superpave volumetric mix design process in 2004 the Bituminous Materials Section has been collecting test data using both the Hveem stability and Superpave HMA mix design processes on every project paved in the state. This review started in January 2005 and will continue until national standards are changed and/or WSDOT alternative identified. Mix design testing completed, now working with Pavement Management Section and sorting through approximately 400+ HMA mix designs to identify candidate projects for evaluation.

Identify and Implement New Moisture Susceptibility Procedure. The implementation of Superpave volumetric mix design process and the phasing out of the Hveem mix design process facilitates the need for a new moisture susceptibility test procedure. This new procedure must include: A process to evaluate variable quantities of liquid antistripping additives; Use test specimens that replicate volumetric properties of HMA mix design.

Status: Surveyed other states to identify alternative moisture susceptibility test procedures. Research indicates that the Hamburg Wheel Tracking Device (HWT) could provide alternative moisture susceptibility test in addition to predicting rutting potential of HMA. Research proposal completed and submitted for funding. Implemented use of gyratory compacted specimens for moisture susceptibility testing until alternative can be determined. No change since last reporting, latest proposal for purchase of HWT submitted November 2009.

Performance Prediction Testing (PPT) Study - Part 2 (Hamburg Wheel Tracking Device). Research project to identify potential of HWTD to measure rutting susceptibility of HMA mixtures in Washington State. Project to include: Review for existing research; Training with TxDOT; Fabricate samples for testing WSDOT mixes by TxDOT; Develop recommendations for WSDOT to implement the HWTD. On completion of project a report will be written and distributed with recommendation to purchase device and potential specification for design and production testing

Status: Research and literature search completed. Working with TxDOT to identify mix design and production specification applications and coordinate on-site training. Research proposal completed and submitted for funding. No change since last reporting, latest proposal for purchase of Hamburg Wheel Tracking Device submitted November 2009.

Aggregate Specific Gravity Study - Part 1 (Mechanical vs. Human). Part one of this study is an evaluation of mechanical methods for the determination of coarse and fine aggregate specific gravity compared to conventional test methods. This study includes: Corelok automatic vacuum sealing device and the Thermolyne SSDetect testing system; AASHTO T84 & T85 aggregate specific gravity test methods.

Status: Testing and final report completed. Final report submitted as taconite for distribution.

Aggregate Specific Gravity Study - Part 2 (Variation in Production). Part two of this study is an effort to measure the variability of aggregate specific gravity in quarry and gravel sources throughout production on select paving projects. This study includes: Identification and selection of candidate projects for evaluation; Scheduling and acquisition of samples; Testing analysis and reporting.

Status: Study was originally scheduled for 2007 construction season on four select projects but samples were not acquired as requested. Additional projects have been identified for 2008, project completion extended until 2009. All aggregate samples received and tested, data analysis and draft report completed and submitted for review.

Performance Graded (PG) asphalt binder (Plus Specifications). Where is the nation going and where is WSDOT going? Currently some states use and an elastic recovery test to confirm the presence of polymer modification while other states use a forced ductility or toughness and tenacity test but there is no consensus for the detection and/or performance of asphalt binder modification. What tests should be used to verify performance of asphalt modification?

Status: In 2007 and 2008 WSDOT used an elastic recovery specification as part of the asphalt binder acceptance testing on trial projects in the Eastern Region. The elastic recovery test does confirm the presence of polymers in asphalt binder but does little to measure its performance. Through the research efforts of the FHWA the Multiple Stress Creep Recovery (MSCR) is being developed for testing the presence and performance of polymer modification. The Bituminous Materials Section has been performing informational MSCR testing on all the asphalt binders used on WSDOT projects since 2007. At the completion of the 2010 construction season a complete data analysis from all projects will be used to recommend possible adoption and implementation in 2011. In addition to the MSCR testing the Bituminous Materials Section participated in an Inter-Laboratory Study (ILS) funded by the FHWA to evaluate the new asphalt

binder low temperature bond test using an Asphalt Binder Cracking Device (ABCD) in 2009. A report of the ILS is pending and will be sent to WSDOT upon completion. The Bituminous Materials Section has prepared a draft report for use as a tech note which outlines the ABCD work performed.

Bob Briggs, Assistant Construction Materials Engineer - Administration

Develop a plan for integrated computer applications for Construction /Materials. Requirements for MATS is currently underway and expect to have an overall plan for future work to be complete by January 2007. Due to delays, this project has been extended to June 2008.

Status: Currently the SPMG group is working on ways to integrate the systems. Eastern Region has developed a system that will be used for field documentation. Mats mix design now is directly inputted into SAM. As the field testing in MATS is developed, more integration will occur with all of the materials programs. Over the next year, we will be developing the field testing portion of MATS. We will also be developing the automatic filing of test reports into MTP and the uploading of test data into SAM. Continued work with rebuilding SAM and adding field testing to MATS. These reports will upload to SAM automatically.

Replace RegTec with Mats within 1 year and continue to develop the remainder of Mats. Development is underway and expect to have the first phase of deployment in January 2007 with the complete deployment of MATS by January 2008.

Status: MATS deployed phase 1 in April 07. Completed HMA Mix Design, and density standards. The rest of RegTec will be replaced by when there is a miscellaneous test report by April 2009. We are working on the core testing and miscellaneous testing. When these are complete, we are looking at July to replace RegTec completely. This is currently on schedule for sometime in July to replace RegTec. Some setbacks with SAM, will work to finish this during the first quarter of 2010.

Work on MTP to satisfy people's need to achieve 100% usage. The plan is to identify the problems in late 2005 and fix the problems in 2006 with 100% usage of the MTP system by January 2007. Due to delays in programming, this project has been extended to April 2008.

Status: The Eastern Region is working on a field documentation system that will require MTP to be used and kept up. With the deployment of MATS, all bid items will come from MTP and test reports will be automatically sent to MTP. A review of the users showed that only 8 PE offices out of 40 were not using MTP. We will be putting on a training class for MTP, as well as all of our computer programs in 2009. The usage is increasing due to the training that we are providing. We completed the 2009 training, and with the Eastern Region electronic field note record, we are at about 80% usage. MTP is mandatory for the 2010 construction season.

Add statistical aggregate acceptance to the standard specifications.

Status: The statistical aggregate acceptance criteria will be defined and added to the standard specifications. This will also include adding all general requirements from section 5-04 and 5-05 into chapter 1-06. The initial work has been started with the aggregate wording, but not sure where to add it. It might go into section 3 of the spec books, see task number 17.

Develop requirements for a HMA mix design submittal program.

Status: As part of the MATS program, we will have a way for the HMA mix designs to be electronically filled out and requested by the contractor. These mix designs will be sent through the project office to the State Materials Laboratory for verification. This strategic direction will be to develop the requirements for programming the HMA mix design submittal process. initial layout complete, will be meeting with all of the contractors in the first quarter of 2010 to refine the requirements.

Development requirements for a concrete mix design submittal program.

Status: As part of the MATS program, we will have a way for the concrete mix designs to be electronically filled out and requested by the contractor. These mix designs will be sent to the project office for approval. This strategic direction will be to develop the requirements for programming the concrete mix design submittal process. An initial meeting has been set for January to start to get requirements.

Development requirements for MTP to allow for document storage.

Status: As part of the ongoing improvements to the Materials Tracking Program, and with the completion of MATS, we need to have an electronic way to store approval documents, acceptance documents, test reports, and other materials documentation in a logical meaningful location with easy access. This strategic direction will be to develop the requirements for programming the document storage process in MTP. This is going to happen with the field testing in MATS in January 2010.

Finish the Materials Testing Program

Status: The materials testing program, MATS, is about halfway programmed. The current plan is to finish all programming by June 2011.

Rob Molohon, Materials Documentation Engineer

Quality control Plans for Aggregate Materials Producers & Suppliers, to include recycled materials (glass, rap, pcc rubble, blast furnace slag, and roofing shingles, foundry slag, and roofing shingles, foundry sand, and so on.)

Status: The development of this standard will be to establish and set protocols for evaluating all aggregate materials to determine their approval status. It will capture all aggregate types of materials and develop methodologies and processes to allow expanded use of recycled materials that are not identified in our specifications such as: foundry sand and roofing tiles. Have not started yet 12/22/09

Specifications for Large Aggregates/Rocks used in Hydraulic Applications.

Status: The WSDOT has had many challenges adequately protecting its Bridge structures from erosion and scouring. This is a team effort between the Materials Documentation section and HQ Hydraulics to develop specifications for large aggregates to address the performance concerns of hydraulic applications. 75% complete, propose gradings currently under review by Hydraulics and Structural Testing as of 12/22/09

Revision to Division 3 of the Standard Specs.

Status: Division 3 of the Standard Specification currently deals with production aggregate sites and does not reflect today's and tomorrow's way of mining and producing aggregate materials. This section will be revised to include current technology, statistical acceptance of aggregates, and requirements for getting on the ASA database. There will be requirements for recycled materials, and blending facilities included in this section. Have not started yet as of 12/22/09

Development of the requirements for a materials approval (RAM) process program.

Status: The development of a materials approval computer program will be another step to achieving the fully electronic Project Engineer's Office. The goal is develop requirements to have the RAM process fully electronic (no paper) and tie into MTP. Have not started yet as of 12/22/09.

Develop and implement a plan for the re-evaluation of QPL products.

Status: One of the recommendations from the FHWA national audit of other State Highway Agencies was to re-evaluation of materials, systems, and processes listed on the Qualified Products Lists. In an effort to address this recommendation the Materials Documentation section will develop a plan and process for re-evaluating materials, systems, and processes identified in WSDOT's QPL. Have not started yet as of 12/22/09.

Develop traffic specification for trailer mounted attenuators.

Status: The current specifications only identify truck-mounted attenuators. As team effort and direction from the Construction Materials Engineer the materials documentation section will assist Traffic Operations in the development of a standard specification that will allow the use of both truck and trailer mounted attenuators. Completed 11/2009, this requirement is in 2010 amendment package.

Linda Hughes, Quality Systems Manager

Develop a basic statistical class that teaches our specification and calculations.

Status: This course is intended to be a brief synopsis of the specifications and calculations used to determine pay factors for statistical acceptance of materials. This course will aid in reducing phone calls to the Materials Laboratory concerning why pay factors are low. Gathered information from old classes. Template is setup for the on-line class.

Randy Mawdsley, Design Build Quality Verification Oversight Engineer

Write a materials documentation guide for design build offices.

Status: This guide is being developed to aid the Design-Builder's QA personnel and the DOT's Quality Verification personnel in Material's approval, acceptance and verification. The shift of these Material's approval, acceptance and verification responsibilities from WSDOT to the Design-Builder has had word of mouth guidance up to this time. The guide goal is to clarify roles and responsibilities to both owner and design-builder. With each new version of the RFP there may be minor changes including the advent of FHWA participation which requires further diligence on the Design-Builder's part.

Develop Materials section for the Design Build Manual.

Status: In a Design Build project, Sections 1-06, 2.25 and 2.28 of the RFP's deal with the quality assessment, methods of acceptance and the quality process. The goal of the materials section of the WSDOT Design-Build manual is to give the DOT Quality Verification organization a path for start up to project closure within the RFP time frames. Lessons learned are being used to facilitate this guidance. The most recent Design-Build projects have moved section 1-06 in to section 2.25. The materials portion of the manual will facilitate that transition.

Marilyn Olson, Chemical Materials Manager

Review and modify the paint specifications, Section 9-08 Paint. Review and subsequent revision of the specifications started in January 2008. This task is 95% complete.

Status: This task was set back about 6% because of questions raised by a suppliers interested in providing pigmented sealer to WSDOT. The topic under discussion is the need for paint chips to define colors.

Reducing the replacement schedule for the ICP and replace it with x-ray florescence.

Status: Presently sorting thru X-Ray equipment types and CCRL/ ASTM applicable methods.

The technique of Infrared Spectroscopy (IR) is being employed to analyze the uniformity of a specific company's epoxy coating system formula over time. Our objective is to test and evaluate the uniformity of these epoxy systems and determine whether we can correlate spectrum differences (chemical formula variations) samples with failing physical testing and whether there was a change to the formulation of the same product.

Status: Samples were analyzed resulting in no correlation between failing samples and formulation changes. Due to the few number of samples this task has been put on hold.

Development of a standard specification for silicone joint sealants used to span joint openings in road and bridge construction that will replace Section 9-04.2(2) Poured Rubber Joint Sealer.

Status: Review of respective specifications has begun, 1% completed

Traffic Striping Paint Metal-free Alternatives- The purpose of this task is to research options for paint used in traffic markings that is free of heavy metals.

Status: Starting date is Dec. 2009. Review of traffic paint began, 1% completed.

Fly Ash, Slag and other Materials- Adding documentation of heavy metals- The purpose of this task is to write a requirement in QC1/QC2 specifications for the periodic requirement of documentation of heavy metals in fly ash samples received by the materials laboratory. Also look at other materials we test to see if WSDOT needs to require periodic information on heavy metals.

Status: This task will begin in Jan 2010.

Dwight Carlson, Electrical and Signing Engineer

This task includes looking at the NTPEP testing for traffic devices and change WSDOT specification and allow for NTPEP acceptance.

Status:

Electric service cabinet quality improvement project. Develop an inspection scheme to improve the quality of electrical service cabinet. Electric service cabinet manufacturers are now performing their own quality control inspection on electrical cabinets. WSDOT electrical inspectors are checking cabinets for QC checklist.

Status: Complete

Update Standard Specifications Section 9-29 Illumination, Signal, Electrical. This section in the Standard Specifications has not been updated in a number of years and needs to be updated to remove outdated requirements and updated to include the latest standards. Need to identify and assemble Expert Task Group to review specifications (ETG Members identified). 17 of 25 sections completed at the end of this reporting period.

Status: With the completion of 9 section of 9-29 this task is 68% complete.

The purpose of this strategy is to investigate how WSDOT can contribute to the use of renewable energy in the daily operation of the highway system. The investigation will include research into how the use of solar energy can reduce the amount of and/or the cost of commercial electrical energy WSDOT consumes, through the use of existing resources or developing resources, in partnership with industry, which would have a predictable pay back. The title of this item was changed to Energy Project and is in include other forms of energy production such as wind generation, as well as other efficiencies that can be achieved.

Status:

The purpose of this strategy is to investigate how WSDOT can contribute to the use of renewable energy in the daily operation of the highway system. The investigation will include research into how the use of solar energy can reduce the amount of and/or the cost of commercial electrical energy WSDOT consumes, through the use of existing resources or developing resources, in partnership with industry, which would have a predictable pay back.

Status:

Research and develop a specification and photometric acceptance for LED based roadway luminaries.

Status:

Al Gabo, Assistant Construction Materials Engineer - Structural

Improve and streamline Annual Plant Approval document submittal and review process through email and scanning results in the finished approved documentation prior to meeting with fabricators for the annual plant approval meeting. July 2007 to June 2009.

Status: Streamlining of Annual Plant Approval process to result in approved documentation. 100%

Cross-training of our E-2's in prestress, precast, crosshole sonic logging testing and miscellaneous materials inspection and documentation for uniformity. July 2007 to January 2009.

Status: Cross training E-2's in prestress, precast, crosshole sonic logging testing and miscellaneous materials inspection and documentation for uniformity is 100% complete.

Review NTPEP as a potential requirement for approval of manufacturers of reinforcing steel and its influence on the HQ Materials Laboratories reinforcing steel sampling and testing program if required.

Status: 5% complete. Working to gain access to NTPEP web site.

Develop Quality Systems Manual Standard Practice Procedures for approval of fabrication plants. Standard Practice Procedures will be separated into standard plant approvals and annual plant approvals. Development will include incorporating Standard Practice Procedures into the WSDOT Standard Specifications.

Status: Development is at the stage of determining the general format of the documents.

Mike Polodna, Structural Materials Testing Engineer

WSU study on the use of low degradation aggregates in concrete.

Status: The first round of testing has been completed. Second round to begin in January 2010.

The WSDOT Construction Manual needs to be updated on how to check concrete mix designs. The construction manual needs to be updated with specific information on what needs to be checked on concrete mix designs so WSDOT Project Offices can independently check concrete mix designs.

Status: The mix design review form has been edited and is ready for inclusion in the Construction Manual.

Geotechnical

Steve Lowell, Chief Engineering Geologist

Develop strategy and implementation plan (including estimated cost, time, and FTE's required) to develop plan to include new and existing geotechnical borings statewide in a GIS database, and begin implementation. Assigned to: Steve Lowell/Lynn Moses.

Status: On hold until funding and staff can be obtained.

Improve horizontal drain effectiveness through development of improved design procedures. Complete pooled fund research study, including assessment of several instrumented field horizontal drain installations. Develop implementation plan to incorporate results into WSDOT design and construction practice. Assigned to Steve Lowell/Tom Badger

Status: Pooled fund study is underway - anticipated completion is end of 2011.

Develop, via a regional pooled fund project, a modified (elevated) wire mesh/cable net slope protection system to improve ability of system to capture rockfall and direct it to ditch at slope bottom. Develop preliminary design with help of Bridge Office. Set up a regional pooled fund research project and obtain funding. Gather results from previous research studies worldwide (Europe, Colorado, previous pooled fund study at WSU on wire mesh slope protection) to estimate likely loads imposed on system. Develop prototype design suitable for field verification testing. Conduct field verification testing (possibly at existing test facility such as the one CDOT has). Implement in WSDOT design and construction practice, including development of standard designs and plan sheets, GSP's, etc. Assigned to: Steve Lowell/Tom Badger
Status: The preliminary Bridge Office design is underway. The regional pooled fund project is yet to be set up.

Update unstable slopes folio to reflect current program status and strategy. Due by: Dec. 2009.
Status: Overall plan of what will be changed in the folio has been developed, concept discussions have been initiated with HQ Graphics, and discussions with Program Management to let them know what support we need from them to complete this folio (including some updated statistics) and to determine a target completion date have occurred. Folio has been completed and distributes by end of 2009, as planned.

Develop residual strength database to improve design parameter selection for landslide analyses. Obtain ring shear testing device to be used to determine the residual strength of soil for landslide projects. Develop database of ring shear (residual strength) test results and correlate with other soil properties such as PI or LL, gradation, residual strength from back analysis of landslide, and also correlate with geologic unit. Assigned to: Steve Lowell.
Status: On hold - waiting for approval to purchase ring shear testing device.

Jim Cuthbertson, Chief Foundation Engineer

Develop the ability to conduct soil specific testing to assess the potential for liquefaction and to provide input parameters for liquefaction design. Obtain cyclic simple shear testing device once funding is available. Also obtain x-ray or gamma ray device to evaluate usability of soil samples for cyclic simple shear testing. Provide training to staff on how to pick test parameters and on how to use the data obtained from the cyclic simple shear tester. Develop database of liquefaction test results and correlate to geologic units. Assigned to: Jim Cuthbertson/Pete Palmerson.
Status: On hold - waiting for approval to purchase cyclic simple shear testing device.

Develop expertise in site specific seismic design, including lateral spreading/flow failure analysis. Start with core seismic staff who already are developing the needed expertise. Develop training plan for core staff to more fully develop their expertise in this area, including attendance at conferences as they become available and are determined to be beneficial to achieving this strategic direction. Obtain or update the necessary computer software to conduct the seismic analyses needed – especially important is obtaining/augmenting non-linear effective stress analysis software. Have core seismic staff consult with other staff who are faced with doing this type of design on their projects, and as they do so, train these other staff on how to do the analyses needed. Continue development/revision of the GDM, especially chapter 6 on seismic design to document the design procedures needed, how to obtain the design parameters needed, etc. Assigned to: Jim Cuthbertson.

Status: The core seismic team members have been selected and are informally recognized as such. One key program has been purchased (DMOD-2000) though there are some key flaws in the program model that need to be overcome. Basic training regarding the use of this program has been completed, but more detailed training is needed. Chapter 6 of the GDM has also been updated to reflect what we have learned on this subject so that the rest of the staff know. Some areas are still under development, such as how to estimate lateral spreading and its effect on foundations more accurately. We need to develop our expertise in FLAC modeling as it relates to seismic design to overcome these problems. We have recently purchased updated FLAC programming and are currently making arrangements to get staff training on its use for liquefaction/lateral spreading and general use of the FLAC program.

Develop soil/rock property database and correlate those properties to geologic units are commonly encountered. Set up database so that as test results are obtained, they can be recorded/stored in an easily retrievable system. Build in flexibility for future use in GIS. Do search of lab data in previous projects recorded/stored in Stellant to help populate the database. As time allows (during less busy times in lab), conduct tests for key properties (shear strength, compressibility, etc.) on existing stored undisturbed samples. Correlate test results to geologic units. Summarize results in Chapter 5 of the GDM to provide design parameter selection guidance based on these results. Assigned to: Jim Cuthbertson/Pete Palmerson/Bob Grandorff.

Status: The complete lab data are being gathered and stored on the M-Drive, for now organized by project. A summary database has not been developed as yet, and we are looking at options on software that could link this data to the data already stored in gINT. Will likely need IT help to fully accomplish this. Once that database is created, we will begin correlating it to geologic units.

Develop investigation and implementation plan for use of geogrids in pavement base coarse reinforcement and as subgrade reinforcement for pavements. B45 Summarize results from nationwide survey. Review research results obtained to date by others, and in consideration of nationwide survey results, determine what is known, and what is not known that needs to be known, developing preliminary design and use policies for geogrids for this application. Identify potential test sites where this trial design policy could be tested. Assigned to: Jim Cuthbertson
Status: The survey has been completed, but the final report on the survey is yet to be completed due to the heavy workload that has occurred during the past year. A final report for a pooled fund study on this subject (WSDOT is a study partner) has just become available. Conclusions at this point indicate that geogrids provide marginal benefit unless the subgrade soil is very soft. However, what we don't know is just how soft the subgrade, or how thin the pavement section, needs to be before significant benefit can be derived from the geogrid. More research is needed, but funding is currently not available. This strategic direction should be put on hold until more research funding can be secured.

Tony Allen, State Geotechnical Engineer

Continue development of the GDM, especially focusing on foundation design for marine structures, addressing the specific needs of WSF, completing an update to the walls chapter, and filling any gaps in the recommended design practice to insure clarity for design-build contracts. Complete updates by Dec. 2009. Assigned to: Tony Allen/Jim Cuthbertson.

Status: Updates to several GDM chapters were completed and reviewed (including FHWA approval) in October 2009 and published in January 2010. The development of new guidance on design of marine structure foundations has been part of this effort but there is still much to do to complete that particular chapter. Anticipated completion of the marine foundation chapter is June 2010. Chapter 15 (walls) is undergoing a major revision (including the geosynthetic wall Standard Plans referred to in that chapter) - anticipated completion is March 2010, with publication by May 2010.

Continue to develop geotechnical design procedures in LRFD format for aspects of foundation and wall design that are not currently in LRFD format (soil nail walls, micropiles, noise walls, reinforced slopes, etc.), primarily through continued participation in the AASHTO Bridge Subcommittee and various NCHRP panels, and possibly other research. Develop updated procedures to submit to AASHTO regarding seismic design of walls, and updated drilled shaft foundation design procedures. Assigned to: Tony Allen.

Status: A major update to the pile design specifications was submitted to and approved by the AASHTO Bridge Subcommittee in July 2009. The first draft of the updated seismic provisions for walls has been completed by T. Allen, and is now under a first cut review by the AASHTO T-3 and T-15 committees. With the new FHWA drilled shaft manual anticipated to be available soon, the next major effort will be an update to the AASHTO Section 10 shaft design specifications.

Develop long range plan to fully implement MSE wall research (K-Stiffness Method). Complete research reports and publish updated design method in well respected journals. This includes development of load and resistance factors using reliability theory, application of method to seismic design and to establish link between working stress design (K-Stiffness method) and limit equilibrium design (compound stability analysis). Work with other states/agencies to identify potential instrumented test walls, including those with lower quality backfill materials to establish accuracy of method. Complete RMC research - scheduled completion date is Dec. 2010. Prepare agenda item for AASHTO to include new design method in the AASHTO LRFD specifications. Assigned to: Tony Allen.

Status: Numerous journal papers on the K-Stiffness Method have been published or are in the publication process in a number of international and domestic journals. The most recent work has been done with the assistance of a visiting scholar from Japan, in which the K-Stiffness method was shown to be valid for a series of Japanese walls, broadening the applicability and acceptance of this research. The method has now also been expanded to lower quality backfill materials through the evaluation of Japanese and other full scale wall case histories, and the K-Stiffness method has been modified to accommodate the cohesion that is usually present in lower quality backfill materials. A lower quality backfill source for use in the RMC full scale walls has been obtained and testing of the full scale lab walls using the lower quality backfill material is nearing completion, so that this adaptation of the K-Stiffness method to cohesive soils can be refined. The final experimental features project report for the SR-18 test walls is near completion. Analysis and numerical modeling of all the data is underway, including calibration work to adapt the method for LRFD wall design. Several papers on the LRFD calibration of the various MSE wall design methods including K-Stiffness, have been recently published or submitted for publication, and are in review. Efforts are also now underway to relate K-Stiffness working stress design to limit equilibrium design, a key final step in developing a complete design protocol for these types of walls.

Pavements

Jeff Uhlmeier, State Pavement Engineer

Update WSDOT Pavement Policy

Status: The WSDOT Pavement Policy document has not been updated since 2005. Several developments have occurred over this period of time and require update of document (BST project selection, dowel bar type selections, etc.).

Refine and update BST project selection (UW study has been completed and specifications have been updated).

Status: BST project selection criteria under development.

Prepare Permeable Pavement Proviso documenting the feasibility of utilizing permeable pavement in Washington State.

Status: Literature search is underway.

PCCP Diamond Grinding Evaluation - A "new generation" technique for diamond grinding of concrete pavements has been developed by industry, and WSDOT test sections will be used to evaluate.

Status: Grinding projects using the new technology were put on hold because of other project priorities.

WSDOT Pavement Preservation Communication Plan - Develop communication strategy and prepare document to communicate a.) the benefits from the P-1 program over the last 30 years, b.) the expected increase in costs or decrease in quality of P-1 not fully funded including discussion of the risks inherent in letting HMA pavements become past due, c.) Consider using folio (four pager), webpage, two-pager, Power-Point and other methods to communicate.

Status: Plan is being developed.

WSDOT Concrete Needs

Status: Plan is being developed to communicate WSDOT's statewide 10 year concrete needs.

Mark Russell, Pavement Design

Summarize WSDOT's performance using Cold In Place Recycling.

Status: Report is under revision based on additional data.

Monitor and evaluate (for at least a five year period or until failure) pavement performance and noise characteristics on the three (I-5, Lynnwood, SR-520 and I-405 - construction in 2009) quieter pavement test sections.

Status: Monitoring of Lynnwood began 2006, SR-520 began in 2007 and I-405 began in 2009.

Continue documenting WSDOT's Experimental Features.

Status: Continuing monitoring construction and performance.

Continue documenting WSDOT's Forensic Investigations.

Status: Continuing follow-up with documenting pavement failures, those that have not performed as anticipated. This activity is ongoing.

Annual Chip Seal Cost Summary.

Status: Review is begun for 2010 contracts

PCCP Smoothness Specification

Status: Project is on hold until measuring equipment can be modified.

Pavement Design Tools for Web

Status: Project is on hold.

Safety Edge Evaluation

Status: Evaluation is beginning

Diamond Grind Specification Revision

Status: Discussion underway with the SC Region. A revised specification will be used on I-82 in 2010

PCCP Roundabout Std. Plan

Status: Plans used statewide are being summarized and a single recommendation is forthcoming.

David Luhr, Pavement Management Engineer

New WSPMS Interface - Contract with Pavia Systems for a 3-year development of user interface for WSPMS.

Status: webWSPMS 1.0 was deployed in July 2009.

WSPMS Documentation - The WSPMS has been successfully functioning for over 40 years. However, no concise documentation of the WSPMS exists. This documentation will summarize the existing publications as well as describe PMS concepts incorporated into the webWSPMS.

Status: WSPMS file processes have been documented, Profilometer calibration has been documented. WebWSPMS requirements document, and API document are complete. Reporting of webWSPMS functions and development needs to be completed.

webWSPMS 2.0 Development - The development of WSPMS will continue with webWSPMS 2.0 version targeted for a series of deployments in 2010.

Status: Purchased Services contract with Pavia has been reduced to \$50k. Planning is underway for different versions to be deployed in 2010. Alpha and Beta sites are active with new development.

webWSPMS Training - Training for webWSPMS will be ongoing. This will include on-line tutorials, Regional on-site training, and Go-To-Meeting demonstrations.

Status: Three tutorials were developed for product launch, and more are needed. Demonstration training was performed at all Regions.

Evaluation of Pavement Life - The Calculation of pavement life in the past few years has not been very rigorous, and many lane-miles of performance have been left out. A thorough method needs to be developed so Pavement Life statistics are automatically generated in the future.

Status: Initial calculations have been performed; results will be analyzed.

Economic Performance Measures - The development of economic performance measures (e.g., \$/lane-mile/year or \$/lane-mile/ESAL) will provide important information on how economically WSDOT is managing its road network.

Status: An initial set of data has been processed, and is available on the Alpha/Beta versions of WSPMS. Working on getting cost information on older contracts.

WSPMS Data Base Audit - Some fields in the database are blank, for certain years. Other data is not consistent. An audit needs to be done to identify problems with the data base and develop remedies.

Status: Work has begun on evaluation of data issues, but no recent progress has been made.

Evaluation of INO, texture and Skid Data - These data items have been collected for years, but a thorough analysis has never been done. The data needs to be evaluated to determine how it could or should be used in WSPMS. One new aspect is use of INO data for estimating grinding quantities.

Status: This work has not begun.

Develop WSPMS Notebook - Similar concept to the "Grey Notebook", the WSPMS Notebook can be a standard repository of statistics, graphs, and other performance indicators that anyone can retrieve off of the internal web site. Items to include: WSPMS lane miles by type, fair or better condition plots, IRI data, construction lane miles by season, project costs, chip seal annual costs and more . . .

Status: Requirements document has been completed. Scope is being modified to not overlap with WebWSPMS. Many functions can probably be included in WSPMS

Tracking P1 Preventive Maintenance -Most Regions have chosen to select preventive maintenance projects (crack sealing, chip seal, and patching) in their P1 program. These sections need to be monitored so that the effect of the preventive maintenance can be evaluated.

Status: Regions have selected projects, and some maintenance work is completed in 2009. Sections will be noted for monitoring in WSPMS.

Administration

Colleen Reynolds, Information Technology Systems Application Specialist

Upgrade Remedy Software to 7.5

Status: This software is the backbone for our Helpdesk and asset management as well as inventory. We have completed requirements and are anticipating deployment in October or November. **Project is on Hold at the present time.**

Internal/External Software Audit

Status: Adobe compliance review is complete, we will continue with other software manufacturers until all software has been identified and purchasing records are attached.

Ed Bellinger, Information Technology Systems Specialist

Disaster recovery

Status: OIT and DOT Server administrators group have made a decision on an enterprise backup/DR solution. FalconStor software backed by XioTech hardware. We are now moving forward with the approval process.

New Conference Room Upgrade

Status: The new conference room in the geo services area has been stripped of all old equipment. Waiting for facilities to complete the construction phase. We have preliminary approval on the type of equipment we will be adding.

Disaster Recovery / Business Continuity Implementation

Status: Currently doing DR/BC analysis. This has been delayed until procurement of enterprise backup hardware/software is complete.

Materials Lab Webpage Conversion to CMS

Status: Currently working with OIT to convert our webpage's to CMS

Shannon Huber-Lusk, Information Technology System Specialist

Develop and document requirements and plan for MATS for Phase 5, 6, 7, 8, 9

Status: Requirements are complete for Phase 1, 2, 3, 4 and the plan is a living document. Requirements are underway for Steel testing and all remaining Physical Testing Lab Section. Field testing requirements are also almost complete.

Kathy Brascher, Information Technology System Specialist

Replace RegTec with MATS and continue to develop the remainder of MATS. Coring Tests are not complete and IAI comparison. Miscellaneous testing is complete. Once Coring and IAI comparison is done.

Status: RegTec is almost replaced we need to finish Core Testing and IAI comparison process. This task is 100% complete.

Replace Smartware with MATS and continue to develop the remainder of MATS.

Status: Bitmix Lab 100% completely replaced by MATS. Physical testing is about 40% replaced. Soil Lab is 90% replaced. Remaining replacement includes Chem Lab, Liquid Asphalt Lab and Electrical Lab.

Business Functions

New or Ongoing Construction/Materials/Pavements Research Projects

Optimal Timing of BST's on HMA and BST Pavements

Previous research determined the Average Annual Daily Traffic (AADT) threshold that we are currently using and modified the standard specifications for BST's. The next step is to determine the optimal time to place a BST on an existing BST or HMA pavement. BST's are seen as an effective and relatively inexpensive method of pavement surfacing, however, there is no reliable method to determine when the most cost effective time to apply a BST. The benefit will be the improved cost effectiveness of BST pavements and will result in better pavement performance and more efficient investments.



Determination of Optimum HMA Density Based on Pavement Performance

With the implementation of the Superpave mix design procedure and the asphalt binder specifications, there is concern that there may be issues related to HMA permeability, which can be offset by ensuring adequate density, with or without the initial secondary consolidation. Through the data in WSPMS and QA Spec/SAM, this research should determine how HMA density impacts pavement performance, and what level of HMA density is necessary to provide long-lived HMA pavements for construction throughout the year. In addition, determine how the QA specification has impacted pavement performance over time – the current HMA density specification has not been modified with the implementation of Superpave.



Determining Changes in Greenhouse Gas Emissions from Circa 1990 to Present Due to Changes in Pavement Technology

Climate change will impact every facet of asset management at WSDOT. Outside forces may drive inappropriate changes due to lack of information or lack of understanding. Understanding of the effects from pavement management, design, and construction can aid in developing accurate measures for climate change and greenhouse gas emissions (GGE). Therefore, the objective is to determine the contributions to GGE reductions due to improved pavement design, management, materials, and construction



Best Practices for the Design and Construction of PCCP

This research will provide the most effective and efficient methods of design and construction for use in PCCP design and rehabilitation/reconstruction. The first part of the study focused on stud wear of PCCP, which is a major obstacle in designing and maintaining PCCP over a life span of 50 plus years. The second part will focus on a life cycle assessment of varied options for reconstructing PCCP.



Development of a New Drilled Shaft Acceptance Method

Drilled shafts using the wet method are typically accepted based on successful results of the Cross Sonic Logging test. This method of Quality Assurance testing can only verify the quality of concrete inside the shaft core and does not provide for verification of adequate concrete cover over the shaft rebar cage. There is a lack of reliable test methods to verify the quality of the entire concrete drilled shaft. This research will determine test methods that may be capable of testing for core concrete quality as well as the presence of adequate concrete cover outside the shaft rebar cage and determine the reliability and cost-effectiveness of those test methods.



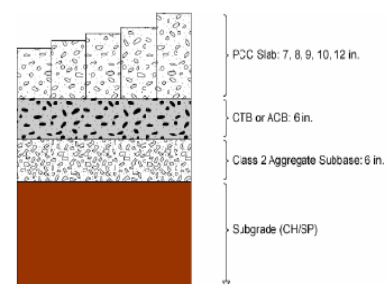
Concrete Performance Using Low Degradation Aggregate

Generally, as low degradation materials are removed from a quarry, they are typically very hard with low LA wear values, therefore typical material testing cannot determine or predict long-term deterioration. As the low degradation materials are removed from the source and subjected to water, this type of material becomes altered to clay and will not perform as expected. This research will evaluate the long-term performance of concrete when using such aggregates, identify the potential long-term problems with the use of low degradation aggregates in concrete, and recommend test procedures and specifications for future use.



CalME Flexible Pavement Design Software Evaluation

This research will provide a demonstration and additional validation of alternative models included in the draft software (CalME) and access to the details of the models and calibration data. Validation of the models and further debugging of the software will be performed by using state DOT project data to predict performance. Documentation of the feedback on the models and software will occur for future use by the state DOTs as they move towards implementation of mechanistic-empirical design methods.



Greenroads

Greenroads is a rating system developed at the University of Washington that distinguishes sustainability-focused new, reconstructed, and rehabilitated roads. It awards credits for approved sustainable choices/practices and can be used to certify projects based on total point value. Greenroads provides (1) a quantitative means to assess the sustainability and environmental stewardship of roads, and (2) a tool for decision-makers that allows them to make informed design and construction decisions regarding sustainability and environmental stewardship of a road. The goal of this research is to develop Greenroads into an implementable standard at the state DOT level.



Effect of Chloride-Based Deicers on Reinforced Concrete Pavements and Structures

The focus of this research is the ingress into concrete of chloride-based deicers currently used by WSDOT for winter highway maintenance. Therefore, the emphasis will be placed on investigating the impact of deicer type and salt contamination on the corrosive behavior of rebar/dowel bars in concrete. The liquid deicers that are being tested include: CaCl_2 , MgCl_2 , and NaCl (all corrosion-inhibited). The control liquid deicer, against which test results will be compared, is non-inhibited NaCl . Testing is occurring on bridge and pavement sections. The bridge sections include plain rebar in the cracked and non-cracked condition. The pavement sections include dowels with a sawed joint – dowel types are: MMFX, epoxy coated, stainless steel tube with epoxy coated inside, 10 mil epoxy coated, and zinc coated.



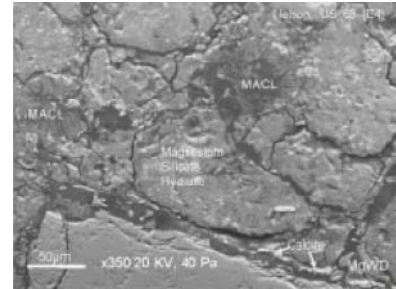
Deicer Longevity and Cost-Effectiveness

The objectives of the proposed research are to evaluate the longevity of corrosion inhibitors in storage and on the road as well as their cost-effectiveness, and to establish a reliable measure to quantify the performance of anti-icing and deicing products. This research will allow the transportation agency to determine whether the inclusion of inhibitors into liquid or solid deicers is cost-effective, taking into account: the acceptable deicer corrosivity, reasonable duration of protection expected of inhibitors, and other agency-specific constraints.



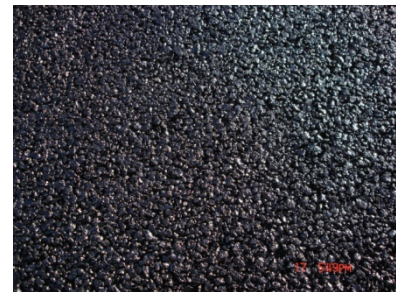
Deicer Interaction with Concrete

Some deicing chemicals used for snow and ice control on roads and bridges may cause deterioration of Portland cement concrete. This deterioration is a complex process that involves both physical and chemical alterations in the cement paste and aggregates and is affected by the deicer chemistry, cement ingredients, aggregate reactivity, and environmental conditions. The long-term effect is the potential degradation on the concrete pavements and bridge decks. The goal of this study is to take concrete samples that are currently being exposed to the typical deicer chemicals used in Washington (NaCl , CaCl_2 , and MgCl_2) and perform lab testing (such as x-ray diffraction, scanning electron microscope technology, etc.) to determine if the concrete is deteriorating from exposure to these chemicals.



Tire/Pavement Noise Research Consortium

This consortium has been initiated to: provide a forum for states to discuss pavement noise issues, utilize the same measurement techniques to build a tire/pavement noise database, create a synthesis of global practice in regards to utilizing pavement technology for decreasing tire/pavement noise, determine the cost/benefits of using low-noise pavements, and provide guidelines for best practices in measuring and evaluating noise benefits and decreases over the wearing life of the roadway surface.



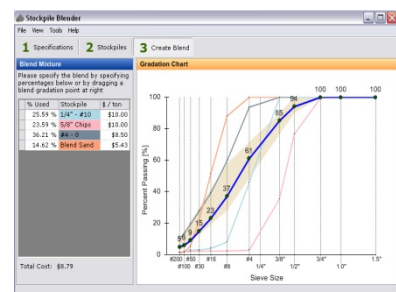
Western Pavement Preservation Partnership

The WPPP will pool the efforts of the participating agencies to provide a focused look at pavement preservation, and will partner with other regional and national pavement preservation efforts. Pavement preservation issues include pavement policy, specifications, field investigations, applied research, materials, and training.



Pavement Tools Consortium

The Pavement Tools Consortium fosters the continued development and implementation of computer-based paving tools, such as: Pavement Guide, Virtual Superpave Laboratory, Media Library, HMAView, PMSView, Stockpile Blender, XPactor, and EverFE. The major focus of the pavement tools is the enhancement of pavement-related training and construction operations.



State Pavement Technology Consortium (SPTC)

WSDOT is partnering with three other states (California, Minnesota, and Texas) which allows participation in a series of project meetings focused on sharing information, identifying critical issues of mutual interest, developing plans for joint research and testing, and educating transportation professionals on the latest developments in the design, construction, reconstruction and maintenance of highway pavements. The benefits of this arrangement have exceeded millions of dollars since its inception in 1999.



Pavement Reconstruction Scheduling Software

This consortium was formed through the SPTC to develop a software simulation tool which can be used to consider pavement design options along with construction scheduling, resource constraints, traffic management, and user-delays. The CA4PRS software is a construction and scheduling analysis tool to make sound construction project management decisions at each stage of the highway rehabilitation project: planning, design, and construction. CA4PRS estimates how many miles of pavement can be rehabilitated or reconstructed under different traffic closure strategies with given project constraints of: pavement design, lane closure tactics, schedule interfaces, contractor logistics and resources.



Ongoing Geotechnical Research Projects

LRFD Procedures for Geotechnical Seismic Design

Develop a framework to determine load and resistance factors that would, accounting for uncertainties in earthquake occurrence and effects, produce designs with reliabilities consistent with those achieved by LRFD procedures for high-probability loading conditions. Development of reliability-based design procedures will allow seismic aspects of design to be consistent with non-seismic aspects, and will allow the reliability of geotechnical elements to be balanced with the reliability of structural elements. They will also allow uniformity across geographic regions – structures in all of the various seismic environments of Washington would be designed for consistent reliability.



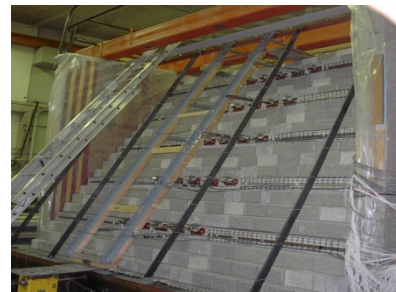
Subsurface Drainage for Landslide and Slope Stabilization

Research is needed to identify, collect and develop best practices and guidelines to raise the standards for subsurface drainage design, installation, and maintenance. This research is especially important because subsurface drainage is typically the most cost-effective stabilization measure, often being an order of magnitude less than other commonly employed slope stabilization measures. In addition, the research should explore new applications of existing materials and technologies that can be advantageously applied to subsurface drainage systems for slope stabilization.



Strength and Deformation Analysis of MSE Walls at Working Loads

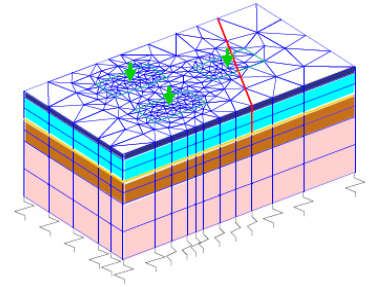
This work has developed an improved method for internal stability design of MSE retaining walls, the K-Stiffness method. This method appears to produce a more cost-effective design for MSE walls as compared to the AASHTO Simplified Method. The K-Stiffness method has only been developed and validated for high quality sandy backfill soils. The next two phases will extend the K-Stiffness method to 1) marginal quality backfill materials and 2) full-scale field walls that will be monitored for validation. The validation of the K-Stiffness method for marginal quality backfill materials and monitoring full-scale walls is necessary to incorporate this method into the AASHTO LRFD design specifications.



Recently Completed Construction/Materials/Pavements Research Projects

EverStressFE Modifications

EverStressFE is a finite element program for the structural evaluation of HMA pavements. Modification and enhancement of this pavement analysis tool is necessary in order to allow for full implementation and use in the calibration of the Mechanistic-Empirical Pavement Design Guide (MEPDG) procedure. The planned modifications will improve the ease of use, functionality, and the appropriate structural modeling of HMA pavements. This in turn will provide for more accurate prediction of HMA pavement performance, which is essential for the successful calibration, verification and implementation of the MEPDG.



Evaluation of Dowel Bar Retrofit for Long-Term Life

The intended benefit of this research will be an improved understanding of dowel bar retrofit (DBR) pavements and a systematic method for best employing the DBR rehabilitation method. This should result in an improvement of pavement service and money savings. The goal is to better understand the issues surrounding DBR construction and its failure modes, thus allowing WSDOT to: (1) better specify construction standards, (2) specify appropriate rehabilitation applications, and (3) extend the effective pavement life of this type of rehabilitation.



Shrinkage Cracking in Concrete Bridge Decks

Recently, all of the WSDOT bridge decks constructed crack within the first 48 hours after the pour due to concrete shrinkage. The cracks occur in the transverse direction and are typically the full depth of the deck. The cracks provide an avenue for water and chlorides to penetrate the concrete and substantially diminish the deck's service life. The outcome of this research is optimum concrete mix designs that minimize shrinkage cracking.



In-House Pavement Research

The following is a list of all completed, in-progress, and new research topics that are being investigated by the Pavements Division. Completed reports and TechNotes are available on the Materials Lab Pavements Division web site at <http://www.wsdot.wa.gov/biz/mats/pavement/>.

Concrete Maturity (**COMPLETE**)

Three projects were reviewed to evaluate the use of maturity to predict the in place strength of concrete pavement. The review found that maturity can be used for the early prediction of strength, however, additional training of both WSDOT and Contractor personnel is needed before this technology can be fully implemented and used statewide.

[Concrete Maturity Final Report](#)



Studded Tire Wear Of PCCP Pavements (**UNDER EVALUATION**)

The performance of portland cement concrete mixes with higher flexural strength, higher cement content, and with Hard-Cem additive will be evaluated over a period of five years to determine if they are more resistant to studded tire wear. In addition, the carpet drag finish will be compared to transverse tining with regard to friction resistance and tire/pavement noise. Results show that wear rates of the test sections are not any better than the standard 650 flexural strength control section. Friction tests indicated that the carpet drag finish was quickly removed by studded tire wear.

[Studded Tire Wear Resistance of PCC Pavements Post Construction Report](#)



Carpet Drag and Longitudinal Tining (**UNDER EVALUATION**)

Experimental features on I-5 Pierce County Line to Tukwila Stage 4 and I-5 South 317th Street HOV (Federal Way vicinity) will evaluate the durability and noise reduction characteristics of the carpet drag surface texture.

[Pierce County Line to Tukwila I/C HOV Stage 4 - Post Construction Report](#)
[Federal Way to South 317 Street HOV Post Construction Report](#)



Trinidad Lake Asphalt (UNDER EVALUATION)

The steel bridge deck on the new Tacoma Narrows Bridge requires a highly crack resistant overlay. HMA pavements on steel bridge decks often use Trinidad Lake Asphalt to improve crack resistance. This experimental feature documents the construction and performance of the HMA overlay with Trinidad Lake Asphalt.

[Trinidad Lake Asphalt Post Construction Report](#)



Quieter Pavement (UNDER EVALUATION)

As a result of the study on *Quieter Pavement: Options and Challenges for Washington State*, WSDOT has developed three Experimental Feature test sections to evaluate the construction and performance of hot mix asphalt open graded friction course (OGFC) quieter pavement. The test sections evaluate two types of OGFC, one that utilizes an asphalt-rubber binder and one that utilizes a polymer modified asphalt binder. Test sections were constructed on I-5 52nd Avenue to SR-526 (southbound only) in 2006, SR-520 between Evergreen Point Road and I-405 in 2007 and on SR 405 between Coal Creek Parkway and SE 8th Street in 2009. The OGFC sections on the first two projects were initially quieter than the conventional HMA but after six months there was no audible difference between the OGFC and conventional HMA. The OGFC-Rubber sections on both of the first two projects are showing up to 5/16 inch of rutting due to raveling from studded tire wear. Initial readings on the third project show the OGFC sections to be initially quieter than the conventional HMA.

[I-5 52nd Ave to SR 526 Post Construction Report](#)

[SR 520 Eastside Quieter Pavement Evaluation Projects Post Construction Report](#)



Warm Mix Asphalt (UNDER EVALUATION)

Warm mix asphalt is a bituminous mixture which can be produced and placed at lower temperatures. Lowering the production temperature means the mix requires less energy to produce leading to a corresponding reduction in greenhouse gas emissions. The lower placement temperature also aids in achieving compaction and reduces worker exposure to fumes. This experimental feature documents the construction and performance of warm mix asphalt placed on I-90 west of the town of George.

[Warm Mix Asphalt Post Construction Report](#)



High Slag Cement (UNDER EVALUATION)

This experimental feature evaluates the ability of concrete produced using high slag cement to resist studded tire wear. Test sections containing high slag cement were constructed on SR 543 in Blaine. The tests sections will be monitored for ride, friction and wear. The Post Construction Report is located at: [High Slag Cement Post Construction Report](#)



MMFX Dowel Bars (IN PROGRESS)

MMFX 2 Steel is an uncoated, high corrosion resistant steel-reinforcing product that meets or exceeds the mechanical properties of ASTM A615 Grade 75 steel. MMFX 2 Steel is a high chromium and low carbon steel in comparison with conventional ASTM A 615 steel. Its chromium content (9 to 10 percent) almost approaches that of stainless steel. The purpose of this experimental feature is to use MMFX 2 Steel dowel bars at each transverse joint in the new concrete pavement.



Pavement Joint Adhesive (IN PROGRESS)

Longitudinal joints are often the first area to fail on HMA pavements. This experimental feature evaluates performance of joints constructed using a bituminous joint adhesive instead of the traditional emulsified asphalt. Preliminary results indicate excellent performance from those projects that used the adhesive



Hot In-Place Recycling (IN PROGRESS)

Hot in-place recycling is a process by which the existing pavement is removed from the roadway, process and repaved as new asphalt pavement in one pass. Hot in-place recycling has the advantage of reusing 100 percent of the old pavement and requires less fuel and produces lower emissions than tradition hot mix asphalt paving. This study will document the design construction and performance of the hot in-place recycled pavement placed on SR 542.



Performance Measures

Construction Materials

Bituminous Materials Section

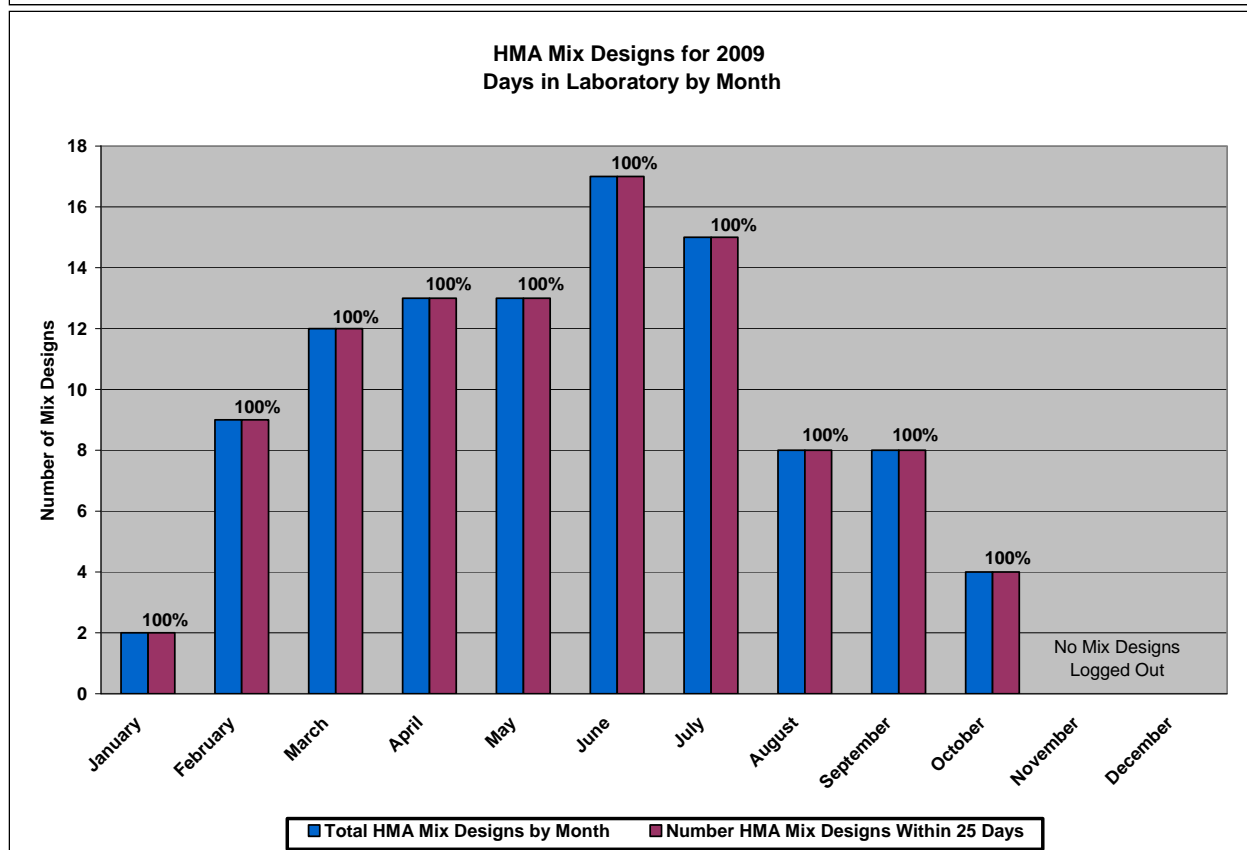
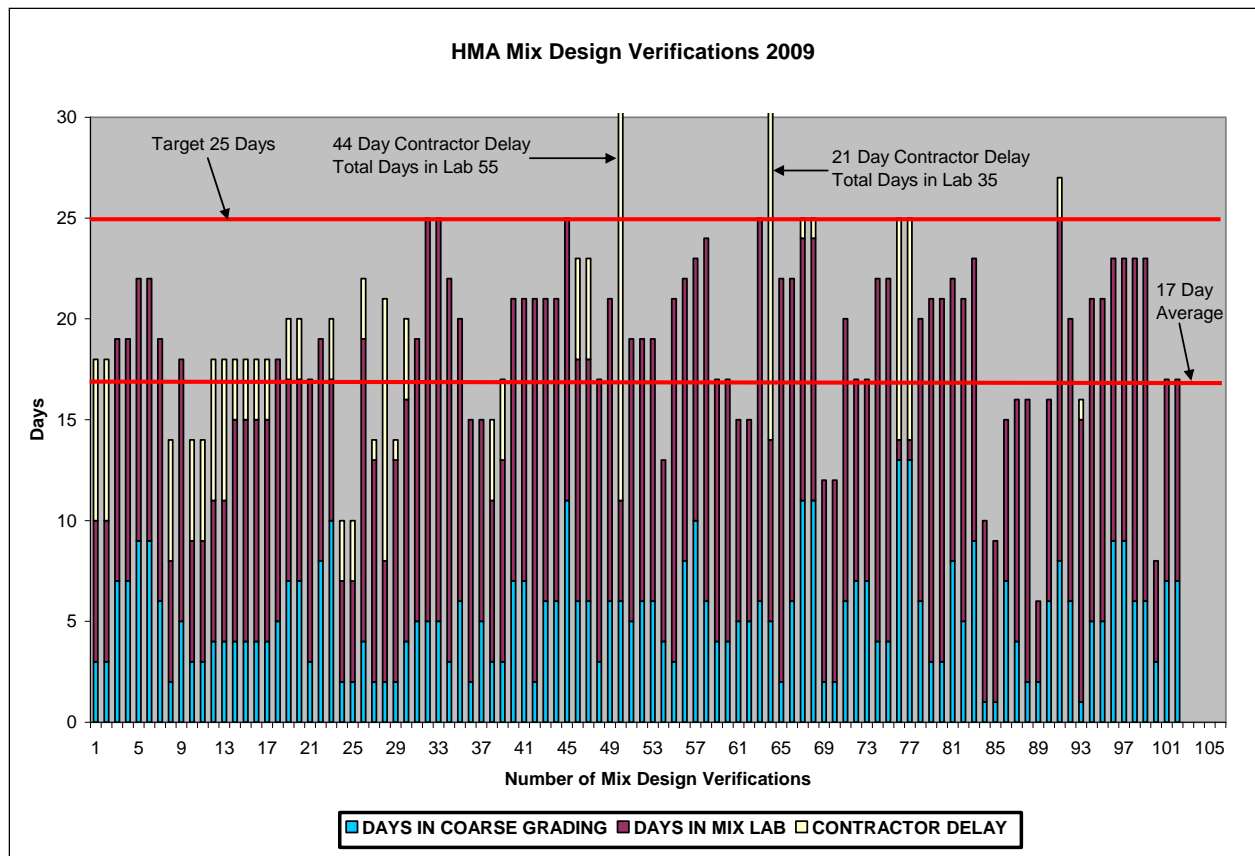
Hot Mix Asphalt Mix Design Verifications 2009

Standard Specification 5.04.3(7)A Mix Designs, states “Prior to the production of Hot Mix Asphalt (HMA), the Contractor shall determine a design aggregate structure and asphalt binder content in accordance with WSDOT Standard Operating Procedure 732. Once the design aggregate structure and asphalt binder content have been determined, the Contractor shall submit the HMA mix design on DOT form 350-042 demonstrating that the design meets the requirements of Sections 9-03.8(2) and 9-03.8(6). A mix design verification report will be provided within 25 calendar days after a mix design submittal has been received at the State Materials Laboratory in Tumwater.”

Factors that can affect the 25 day completion schedule:

- Work load in Physical Testing Section
- Undersized or non-representative samples
- Delays in asphalt binder shipments from suppliers
- Work load in the Bituminous Materials Section
- Special handling of designs
- FTE's
- Equipment and laboratory space
- Overtime authorization

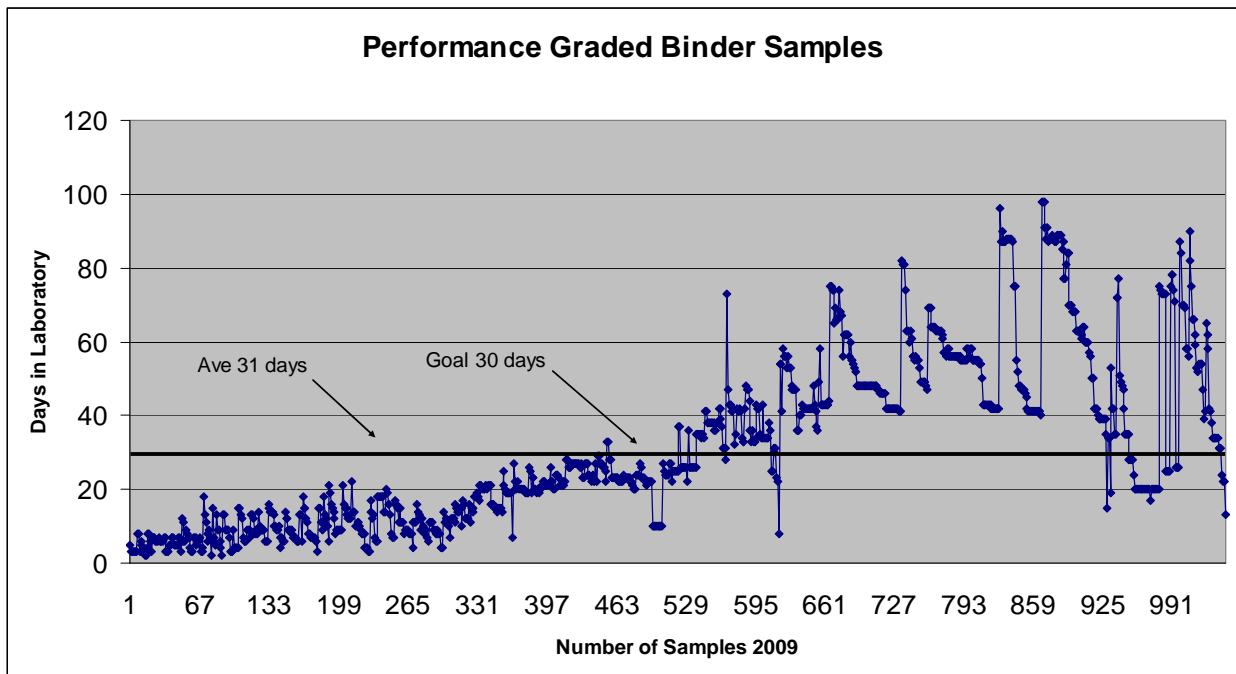
In 2009 the Bituminous Materials Section completed 101 HMA mix design verifications. 98 of these design verifications were either completed on or before their due date. 3 design verifications were not completed within 25 calendar days for reasons not attributed to the State Materials Laboratory. 2 of the design verification delays were due to late shipment of asphalt binder to the State Materials Laboratory and 1 design verification delay was due to the contractor submitting incorrect data on the HMA Submittal form.



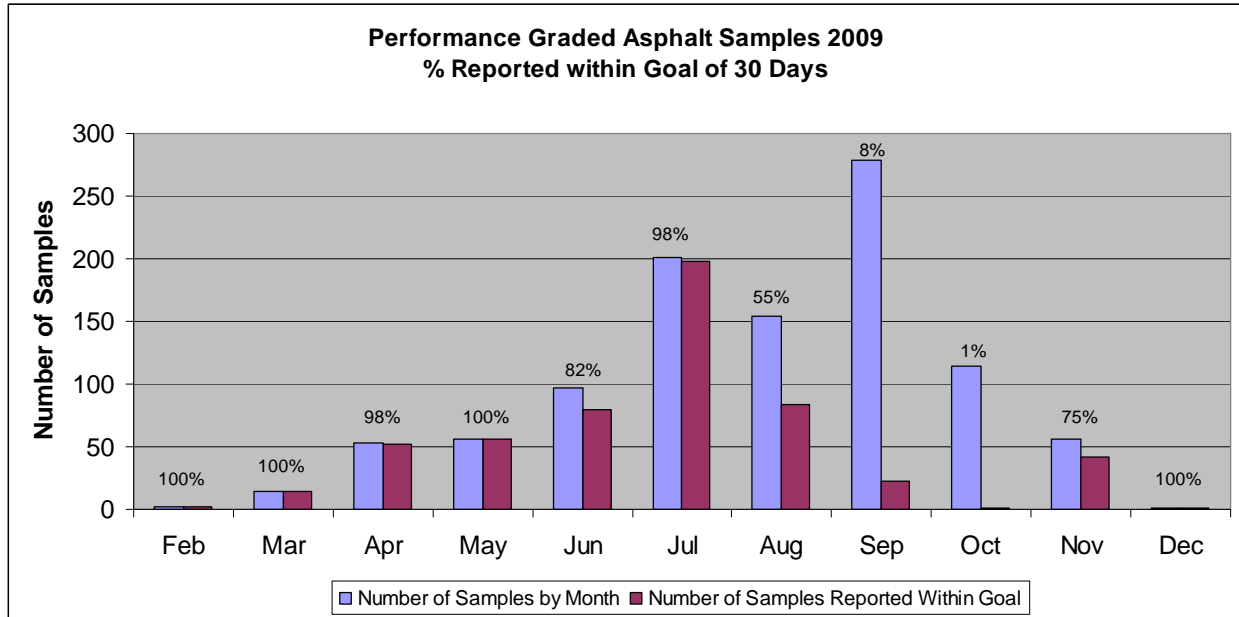
Performance Graded Asphalt Binder Testing 2009

As stated in the Construction Manual section 9-4.2, PG asphalt binder samples must be approved by the Qualified Product List. Samples for verification conformance will be taken based on the frequencies stated in section 9-3.7 (Acceptance Sampling and Testing Frequency Guide). PG asphalt binder samples for verification are taken with every other mix acceptance sample, every 1600 tons of Hot Mix Asphalt (HMA) produced on a construction project.

Due to the large volume of samples received during the construction season, the Liquid Asphalt Laboratory does not test all samples. For PG samples the first, third, fifth and every fifth sample thereafter are tested per contract, per supplier. If a sample does not meet specification, previous and subsequent samples are tested until the window of failure is captured. This policy brackets any failing samples, indicating the extent of the failure.



The Bituminous Materials Section goal for Performance Graded Asphalt Binders is to have all samples that are tested and logged out within 30 days. Due to different testing temperatures used with different grades of PG binders, additional samples outside the normal testing protocol may need to be tested in order to achieve the 30 day goal.

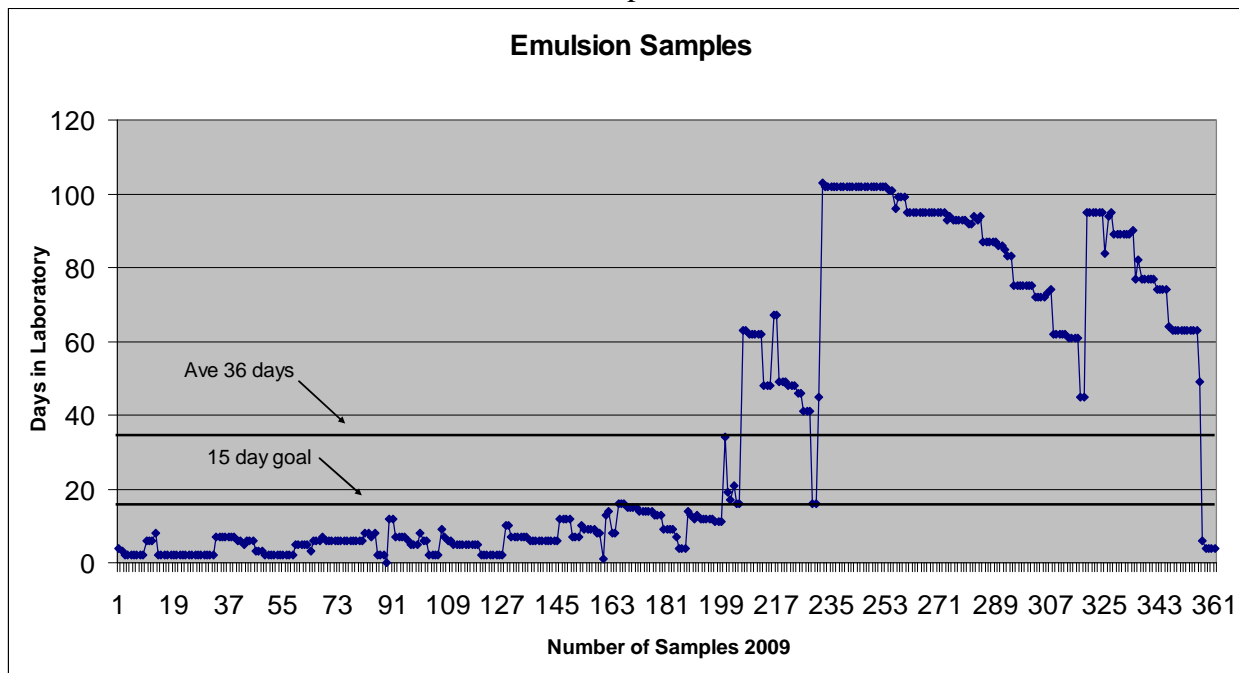


Due to high volume and administrative inefficiencies, late season goals for reporting samples were not met. Reporting processes are under evaluation and a plan for achieving the reporting goals will be implemented. This plan will include the use of additional staff to assist with the workload and the use of overtime during peak periods if needed.

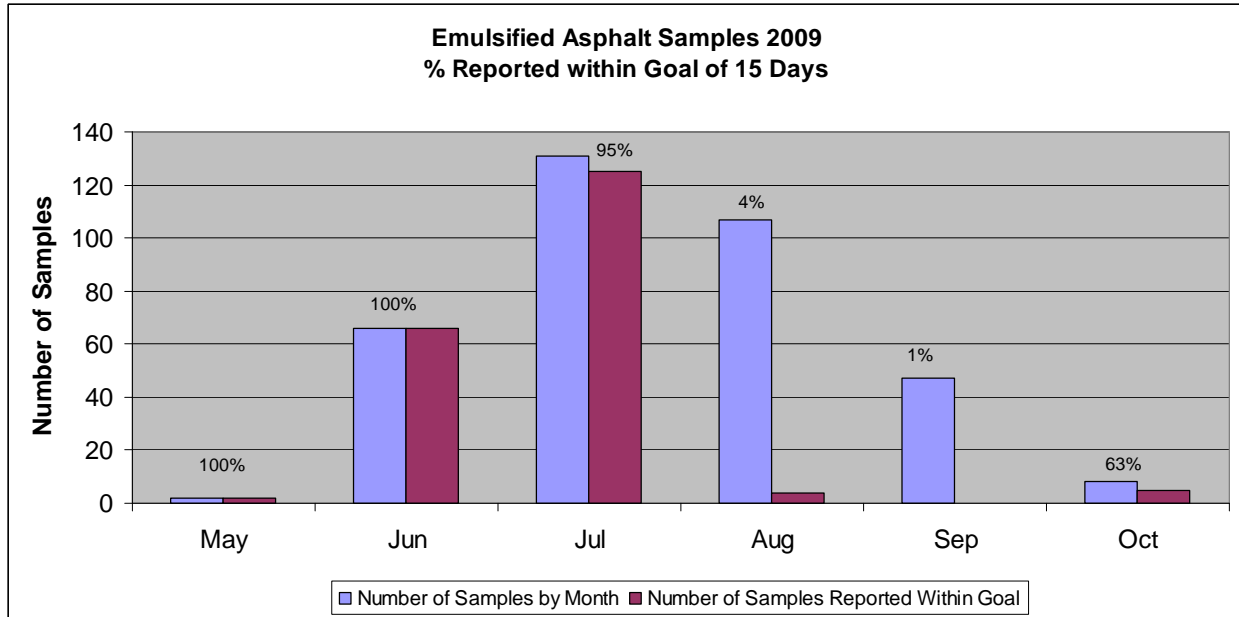
Asphalt Emulsion Testing 2009

As stated in the Construction Manual section 9-4.2, Emulsified Asphalt samples must be approved by the Qualified Product List. Samples for verification conformance will be taken based on the frequencies stated in section 9-3.7 (Acceptance Sampling and Testing Frequency Guide). Asphalt Emulsions shall be sampled from every other shipment to the project. The first Asphalt Emulsion sample taken for each day of production, per contract, receives a complete battery of tests per Standard Specification 9-02.1(6) and 9-02.1(6)A, all other samples taken that day will be tested for viscosity only.

The chart indicates the time for all emulsion samples tested in 2009.



The Bituminous Materials Section goal for Asphalt Emulsions is to have all samples tested and logged out within 15 days. To achieve this goal the Liquid Asphalt Laboratory may utilize additional days and overtime to ensure that testing begins on all emulsion samples within 5 days of receipt.

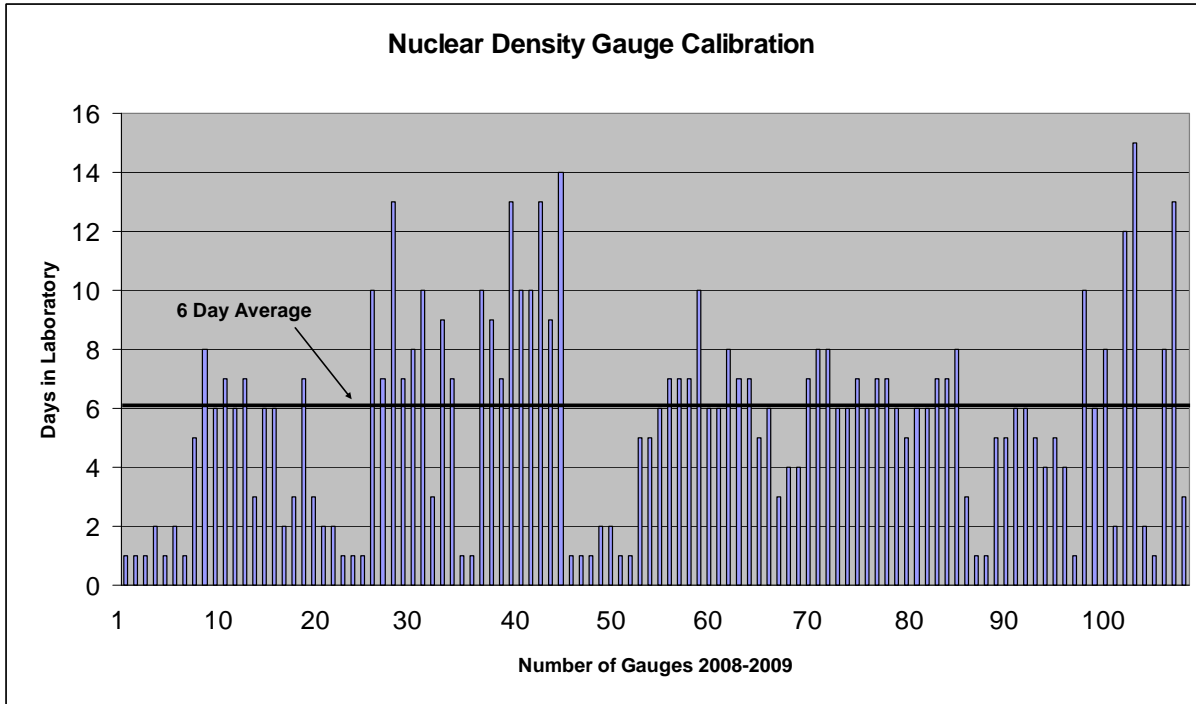


Due to high volume and administrative inefficiencies, late season goals for reporting samples were not met. Reporting processes are under evaluation and a plan for achieving the reporting goals will be implemented. This plan will include the use of additional staff to assist with the workload and the use of overtime during peak periods if needed.

Nuclear Density Gauge Maintenance and Calibration 2009

The Bituminous Materials Section, Nuclear Electronics Laboratory, performs the annual maintenance, calibration and repair of all the nuclear density gauges owned by WSDOT. Technicians with specialized training in diagnostic repair and service keep the department's one hundred and seven density gauges operating efficiently for use in acceptance of base, intermediate and surface materials. This performance measure is designed to evaluate the timely completion of the annual maintenance and calibration of WSDOT's nuclear density gauges and monitor annual efficiency.

It takes approximately three months to complete the maintenance and calibration of all the gauges so this work is scheduled in the winter months when most density gauges are not in use on construction projects. The average turnaround for gauges in 2009 was 6 days. Repairs to the density gauges are performed throughout the year as needed. Performing maintenance, calibration and repair by trained WSDOT staff results in considerable time and cost savings to the department. Shipping, calibration, maintenance and repair costs would be significantly higher if this work was outsourced. The turnaround time of outsourcing this work would also impact the time sensitive testing on construction projects.



HMA Mix Design Conformation Samples 2009

In 2007, the Bituminous Materials Section began measuring the timeliness for completion of HMA Mix Design Conformation Samples. Mix design conformation samples are actual split samples taken during production and tested for comparison to original mix design properties. For all projects, conformation samples are taken one per day from the first five days of production for each plant and one sample every fifth day of production thereafter. This production data can also be used to determine if a mix design is acceptable for use on additional paving projects. The Bituminous Materials Section occasionally tests challenge samples and/or assists in the troubleshooting of problematic HMA issues outside the normal conformation sample testing schedule.

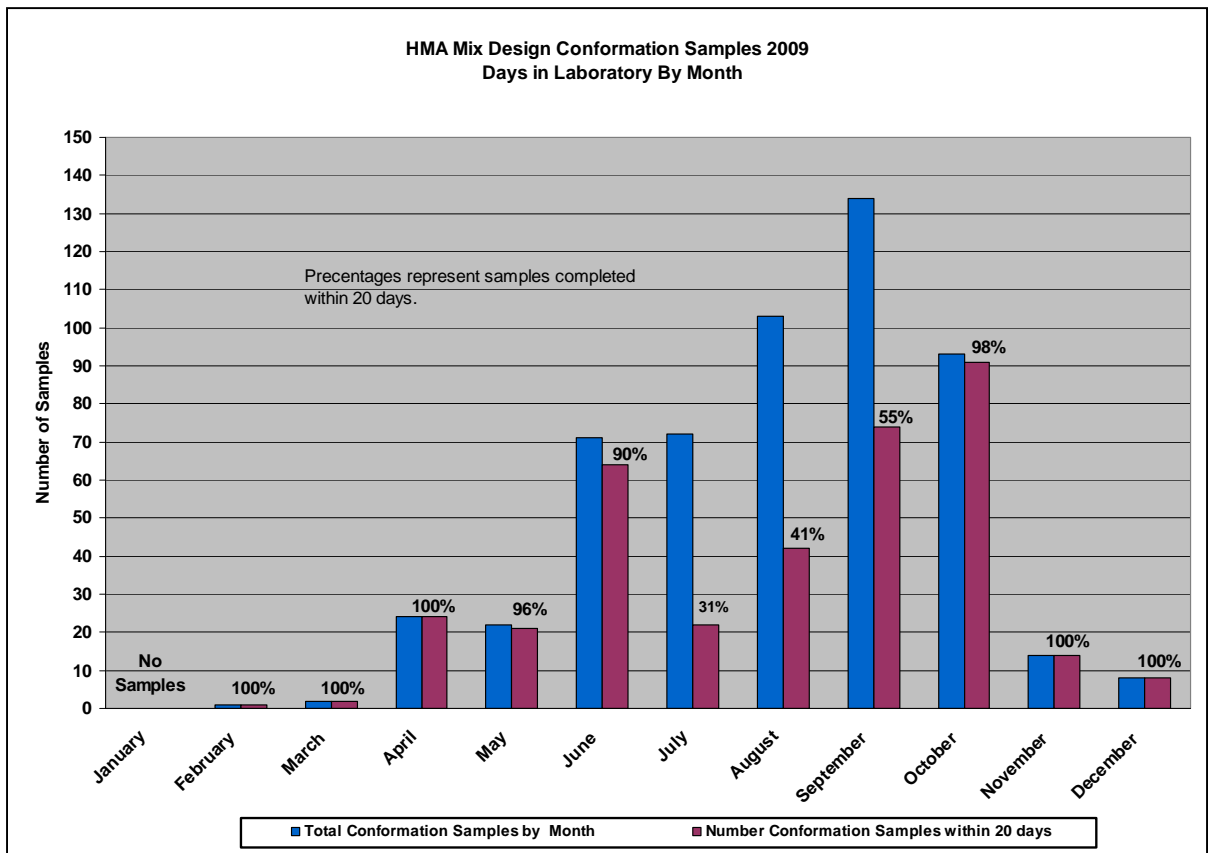
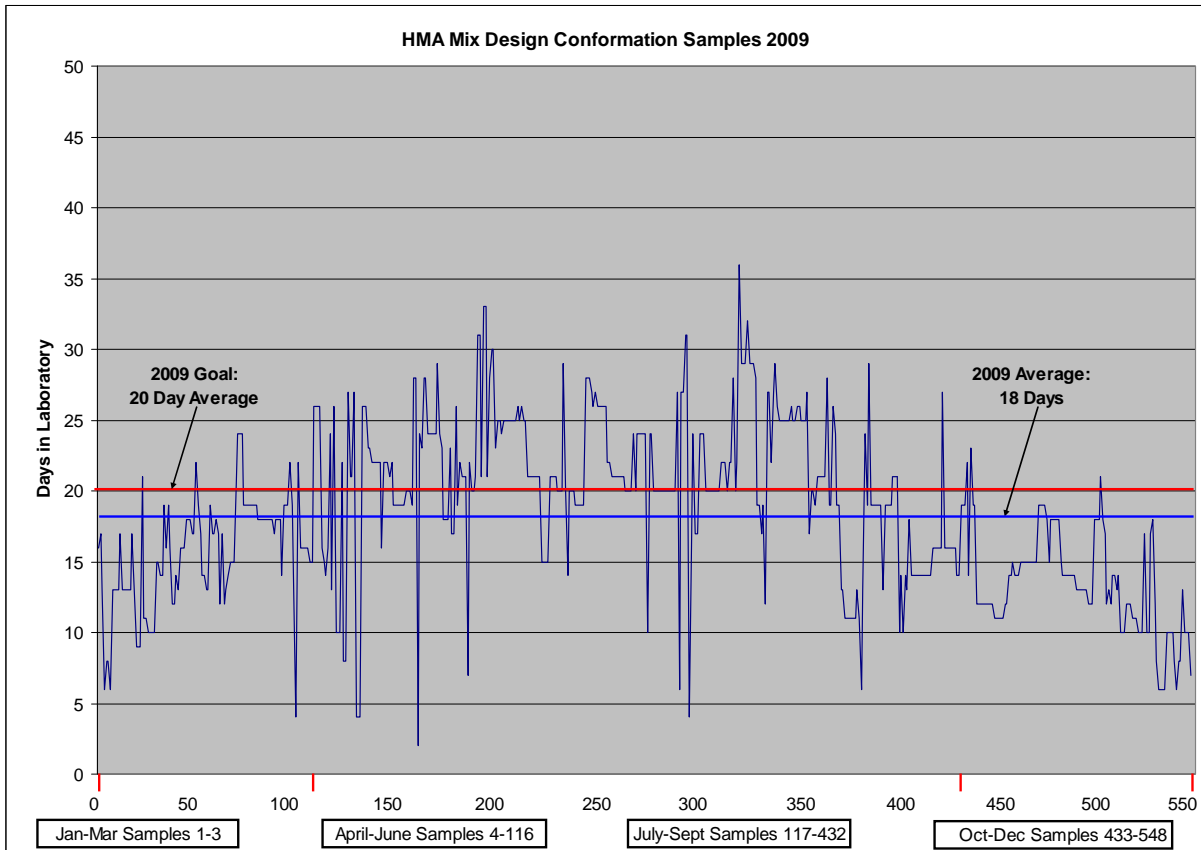
The basis for this Performance Measure is measured by the number of days from when the sample was received at the Headquarters Materials Laboratory until it is tested and logged out by the Bituminous Materials Section.

Although conformation samples do not have a formal timeline for completion, the 2008 construction season was used to measure and monitor the completion of samples and establish a timeliness goal for 2009. Based on the 2008 average of 17 days the Bituminous Materials Section set a goal for mix design conformation samples to be completed within an average of 20 calendar days.

Factors that can affect a timely completion schedule:

- Workload in the Bituminous Materials Section
- FTE's
- Equipment and space
- Overtime authorization
- Project Engineer delays

In 2009, the Bituminous Materials Section tested 548 HMA mix design conformation samples. The average time of completion for these samples was 18 calendar days. 58% of conformation samples were received in the months of July, August, and September. During these months mix design verification testing also increases, which has a 25 calendar day maximum per Standard Specification 5-04.3(7)A, making this the most challenging time to achieve the 20 day goal. Mix design conformation samples were tracked weekly throughout 2009 and compared to mix design verification testing. Monitoring the conformation samples in this way helped identify samples that were approaching or past the 20 day goal.



Chemistry Section

Testing of routine samples should be completed within the specified turn-around time that falls into three broad categories.

Testing of lane markers, paint materials and fencing materials should be completed within five working days from log-in to reporting-out from the Chemistry Section as follows:

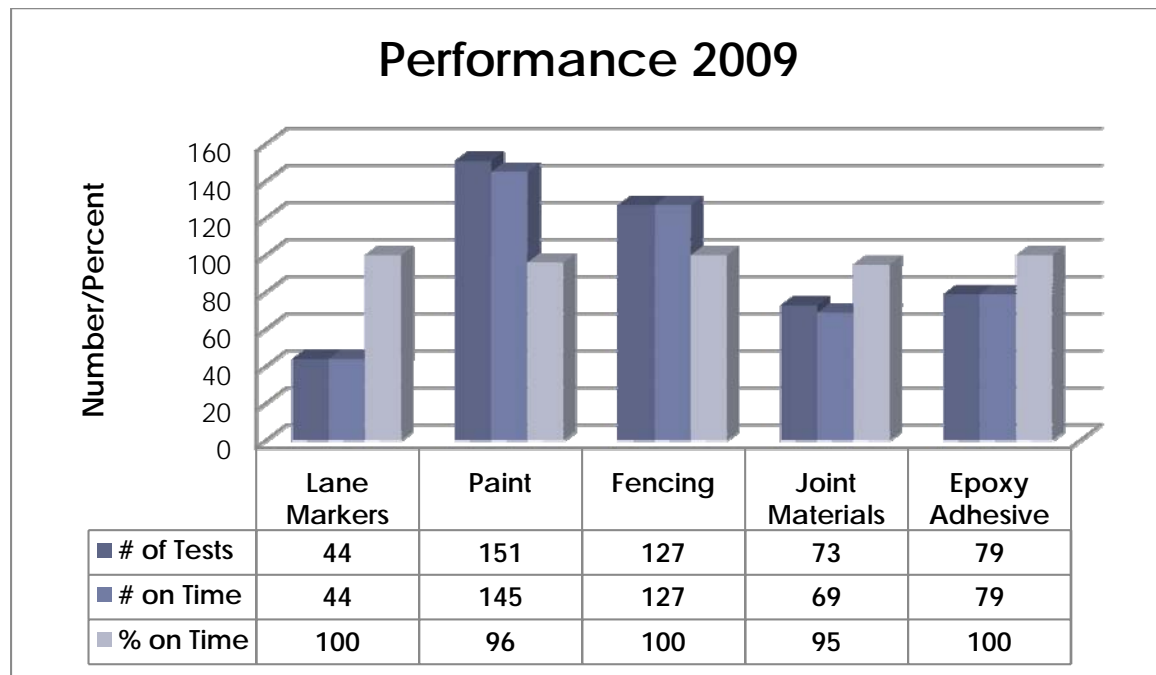
- Lane markers met the completion time for 100% of the 44 samples tested
- Paint materials met the completion time for 96% of the 151 samples tested
- Fencing materials met the completion time for 100% of the 127 samples tested

Testing of joint materials should be completed within ten working days from log-in to reporting-out from the Chemistry Section as follows:

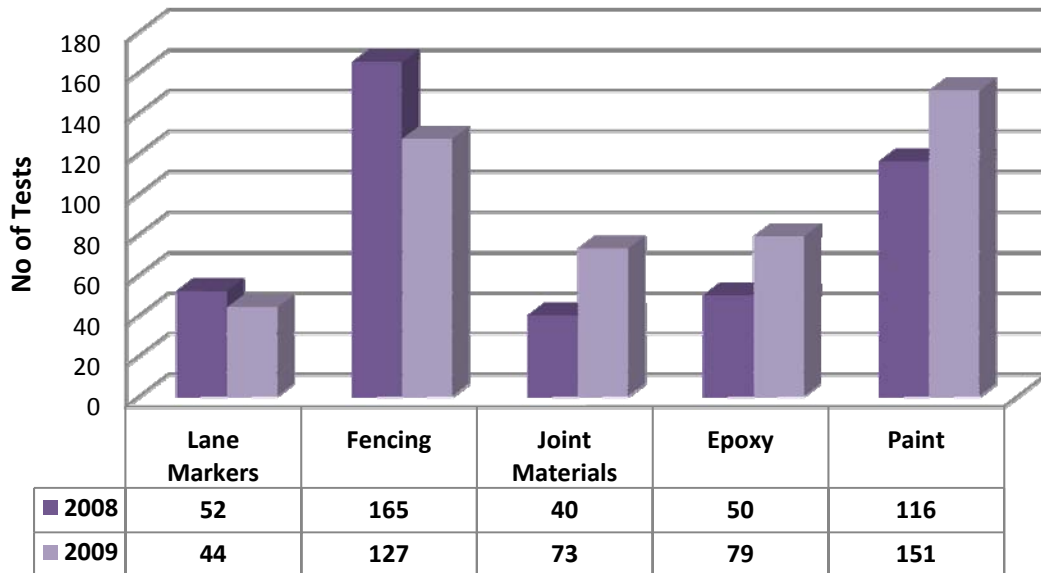
- Joint materials met the completion time for 95% of the 73 samples tested

Testing of epoxy adhesives should be completed within seventeen working days from log-in to reporting-out from the Chemistry Section as follows:

- Epoxy adhesives met the completion time for 100% of the 79 samples tested



Volume Comparison 2008-2009



	<u>2008</u>	<u>2009</u>	<u>Change</u>	<u>Volume Difference</u>
• Lane Markers	100%	100%	No Change	18% Down
• Fencing	100%	100%	No Change	30% Down
• Joint Materials*	100%	95%	5% Change	45% Up
• Epoxy Adhesive	100%	100%	No Change	37% Up
• Paint *	100%	94%	6% Change	23% Up

* Testing procedures have been changed to reflect immediate testing initiation.

Electrical Section

The attached stack bar chart titled Performance Measures 2009 represents the amount of time used for each of the traffic controller assemblies tested at the Materials Lab from 9/30/2008 to 10/1/2009. The total length of the bar represents the total time the controller assembly was resident at the lab for testing. The bar is divided into two sections: the upper section represents the amount of time used by the lab to complete the evaluation of the controller assembly; the bottom section represents the amount of time spent waiting for the vendor to correct problems discovered during the evaluation.

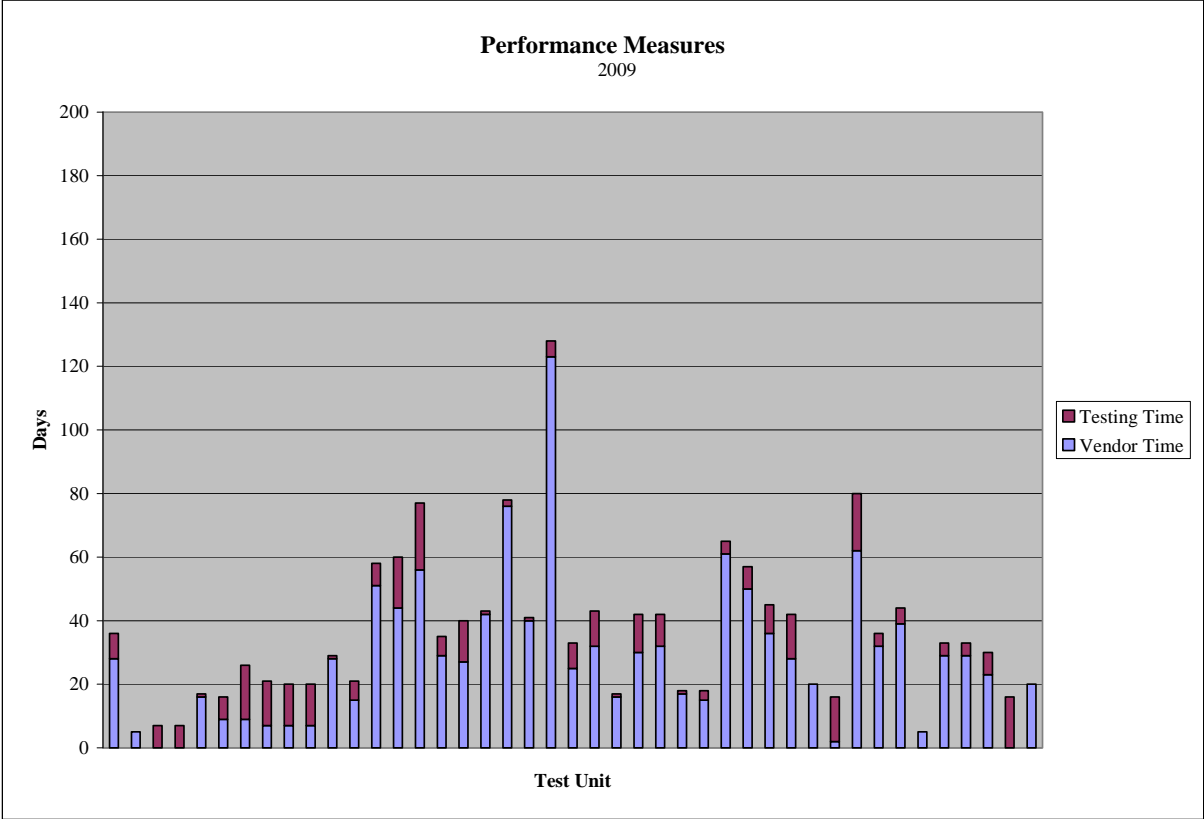
The average number of days required to complete the evaluation of a traffic controller assembly for the period of 9/30/2008 and 10/1/2009 was 36 days, as compared with 44 from the previous reporting period. During the same reporting period the average Vendor Delay increased from an average of 28 days to an average of 31 days while the average Test Time was 7 days. Presented in the following table are the statistics of each of the distributions: Total Time, Vendor Delay, and Test Time, for 2007, 2008 and 2009.

Year	2007			2008			2009		
days	Total Time	Vendor Delay	Test Time	Total Time	Vendor Delay	Test Time	Total Time	Vendor Delay	Test Time
Average	38	31	7	44	28	17	36	31	7
Max	99	96	32	192	189	91	128	123	21
STD	22	22	7	35	36	16	24	23	6

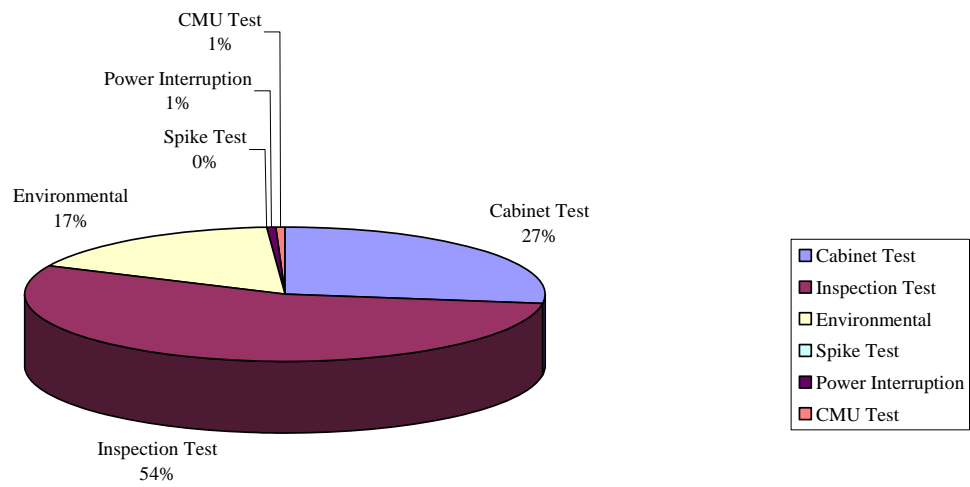
In an analysis of the data used in the chart the average total time dropped to 36 days from the 44 shown for year 2008. The decrease in average total time can be explained by the decrease in testing time. The decreased test time is because the testing back log had a more uniform distribution of cabinet deliveries to the lab for testing. The goal for this next year will be the same as last year, to not let the total time go past 29 days.

During the reporting period of 9/30/08 to 10/1/09 a total of 43 traffic controller cabinet assemblies were tested. There was a total of 176 nonconforming items identified while testing the 43 cabinets. The chart titled “Vendor Quality Performance” shows the distribution of the nonconforming items with respect to the test that identified the nonconforming item. This chart is included to provide information on the continued tracking of nonconforming items seen during traffic controller assembly testing. The most interesting feature about the chart is that more than 91 % of the identified nonconforming items continues to be found with a simple inspection and

wiring test.



**Vendor Quality Performance
2009**



Construction Materials Administration

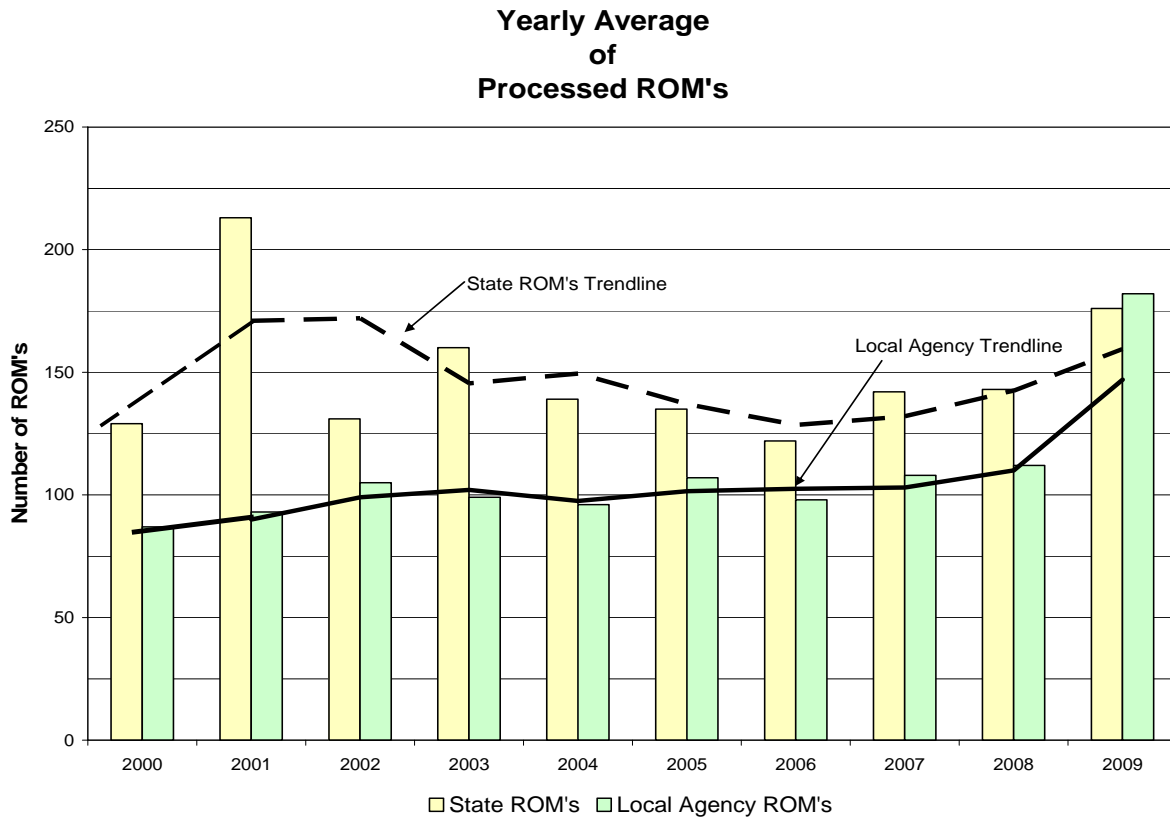
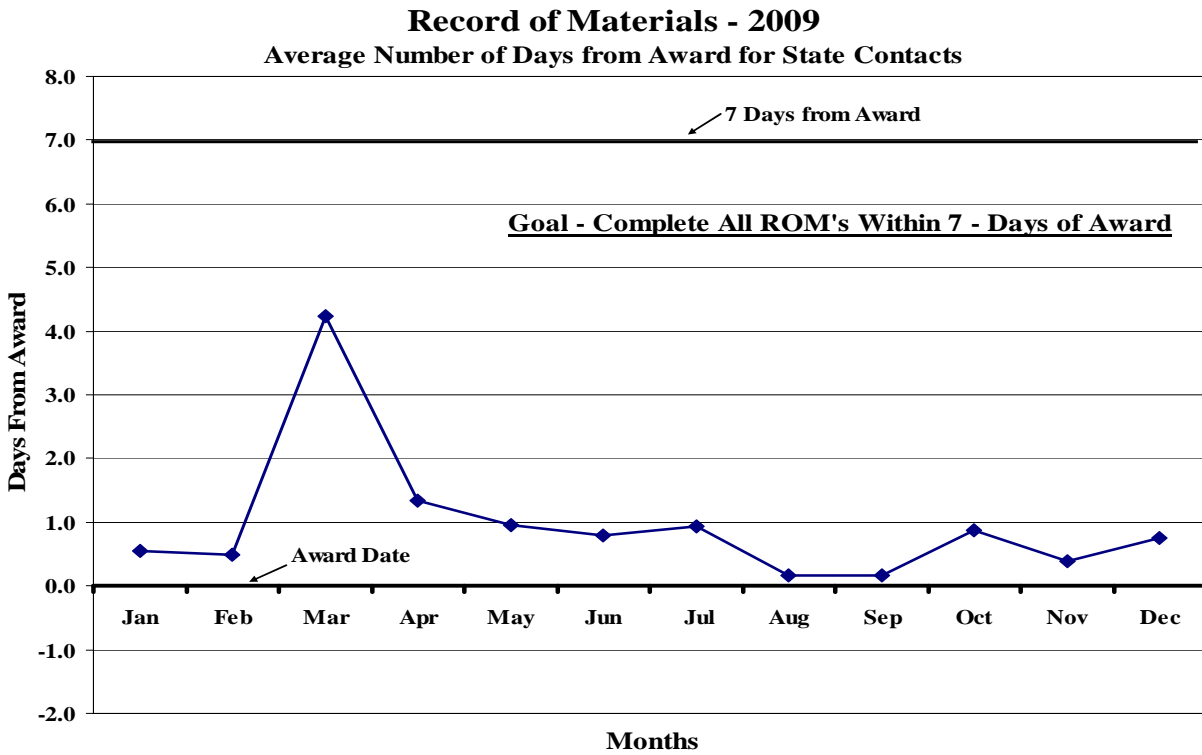
Documentation Section

Record of Materials

A Record of Materials (ROM) is prepared by the Materials Laboratory Documentation Section for every WSDOT construction contract and many local agency construction contracts. The ROM report is a list of all major construction items intended for use on each specific contract, taking into account the contract which includes Contract Provisions, Contract Plans, Standard Specifications, Construction Manual, Standard Plans and the quantities of those materials deemed to require acceptance testing. It further identifies the minimum number of acceptance and verification samples required for acceptance of those materials, with reference to total quantities and respective specification criteria. Also listed are products requiring other actions, such as fabrication inspection, manufacturer's certificate of compliance, shop drawings or catalog cuts that may need to be performed or acquired prior to installation of each material in the field.

The ROM is processed by the Documentation Section and forwarded electronically to every Project Office or appropriate Local Agency. The office administering the construction project can then provide this information to the Contractor and/or use it themselves to determine appropriate testing frequencies and acceptance criteria for each material or product used on the project.

The Documentation Section's goal is to complete the ROM within seven days after the contract is awarded. The performance goal was developed based on feedback from regional personnel and the necessity to wait as long as possible to allow for incorporating any last minute addendum that may apply to the contract.

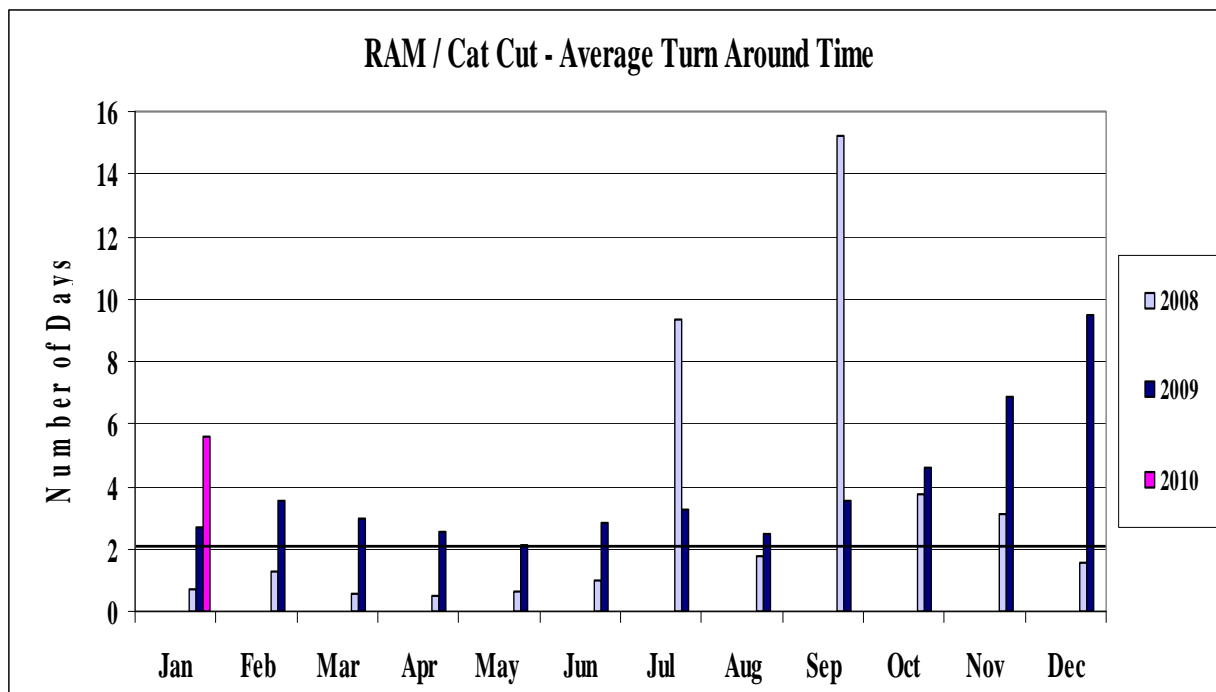


Request for Approval of Material and Catalog Cut

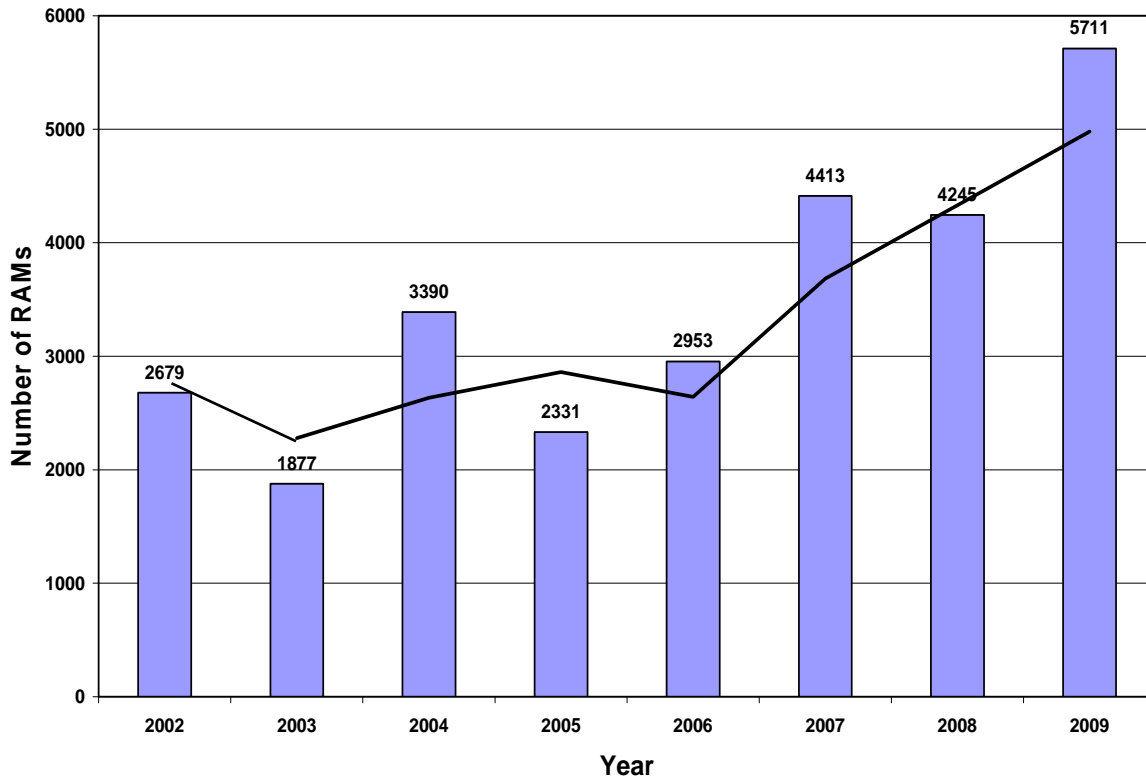
A Request for Approval of Material (RAM) is prepared by the Contractor and submitted to the PEO (Project Engineer's Office) for each product or material anticipated for use on a construction project. The purpose of a RAM is to approve a product or material prior to it being placed on a construction project. Depending on what is known about the product or material, testing may be done to determine if the product or material meets the requirements of the contract. In certain instances additional information is needed to review a product or material for approval. The review of Catalog Cuts is a method of verifying, for approval, products within the RAM process.

The RAM or Catalog Cut is processed by the PEO and forwarded to the Materials Laboratory Documentation Section when the Project Office has insufficient information to approve the product or material. An alternate to submitting a RAM could be choosing a product or material already evaluated and approved via the QPL (Qualified Products List) process.

The Documentation Section's Goal is to complete all RAMS and Catalog Cuts within two days of receiving the RAM. The performance goal was developed based on past turnaround time for processing each RAM. Prior to approving a material or product on a RAM and Catalog Cut we often will need to consult with various Subject Matter Experts within WSDOT to gain concurrence to use the product or material. RAMs that must be sent to WSDOT's SMEs may take longer to process.



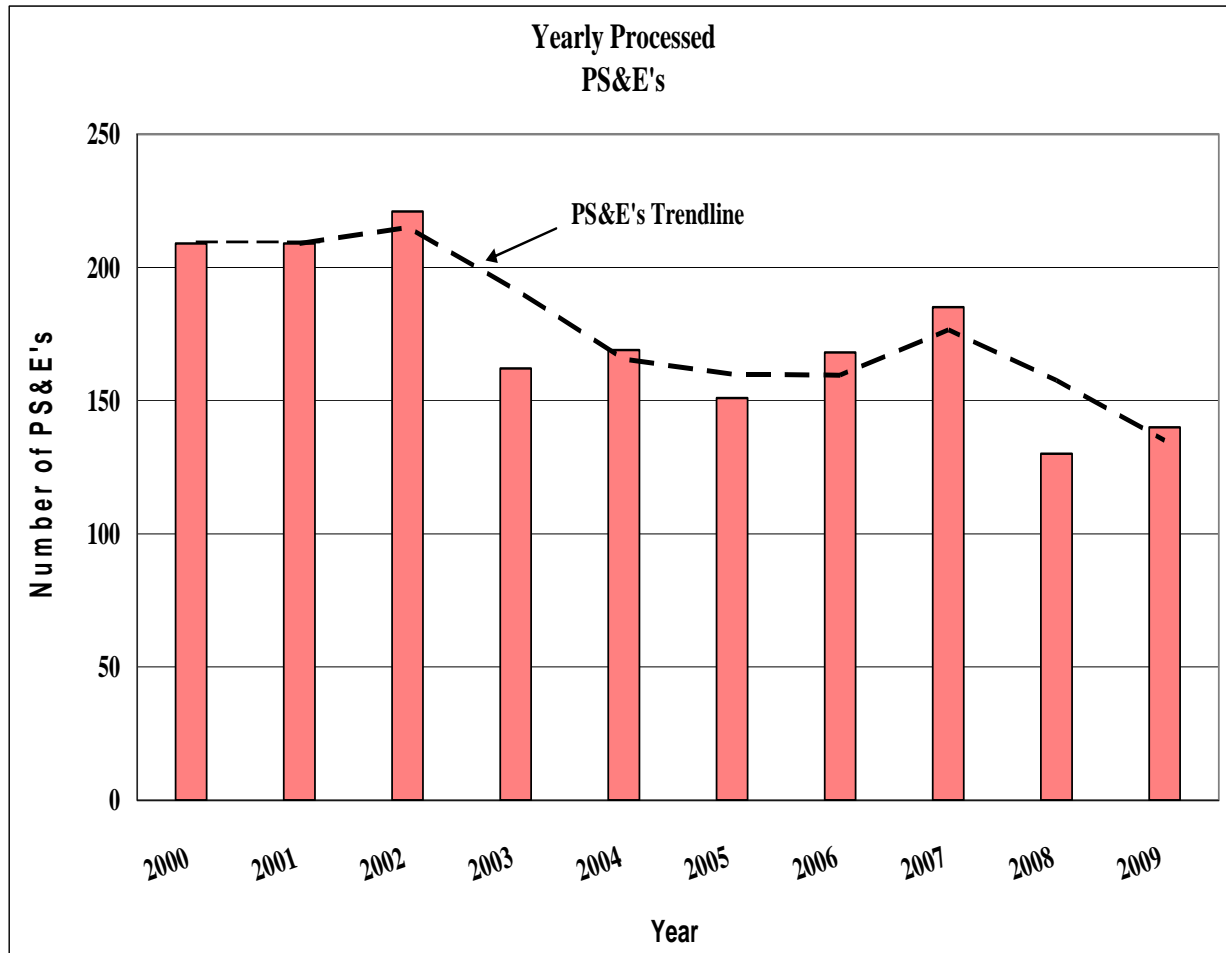
Yearly Average of Processed RAMs/Cat Cuts



Plans, Specification & Estimate Review

Plans, Specifications & Estimates (PS&E) are the preliminary draft form of a construction Ad & Award contract. The Materials Laboratory Documentation Section reviews all Ad & Award copies and determines what Subject Matter Expert in the Laboratory will need to perform a review. The comments from the Subject Matter Experts are gathered and returned to the designer so that the Ad & Award can be completed. There are 'Standard' PS&E and 'Bridge' PS&E that are required to be reviewed.

The Documentation Section's Goal is to distribute and assist the Subject Matter Experts in the State Materials Laboratory to expedite the review in a timely manner. A thorough review and making changes at the PS&E phase will ultimately reduce the needs for changes during the construction phase of the Ad & Award and save engineering costs in the Project Engineer Office.

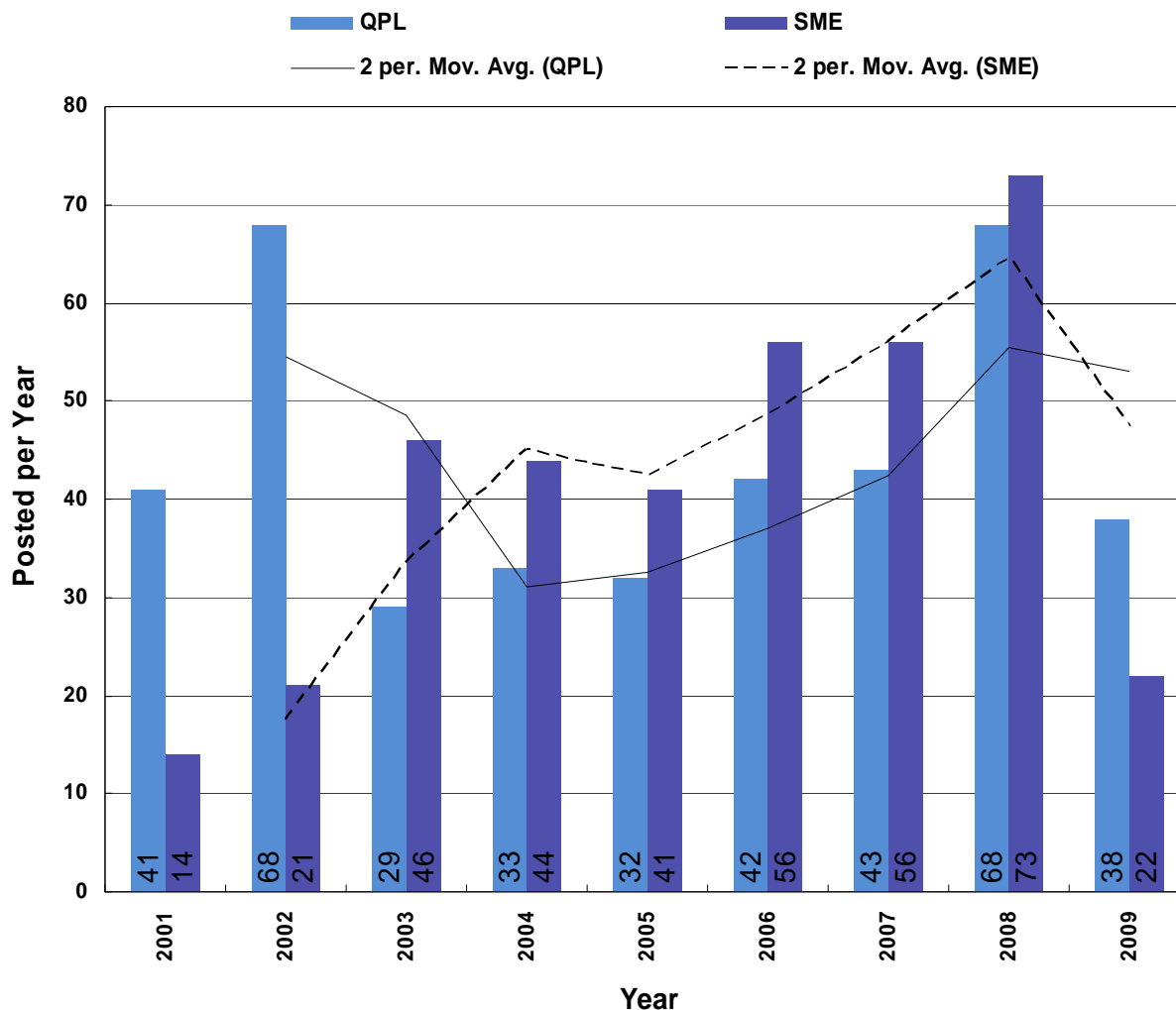


Qualified Products List

The Qualified Products List (QPL) is a list of approved products, materials and systems identified by the Washington State Department of Transportation (WSDOT) Standard Specifications, General Special Provisions, Bridge Special Provisions and Standard Plan compiled by the State Materials Laboratory Documentation Section.

The Documentation Section's Goal is to make a tool available to Contractors and PEOs to assist in the planning and execution of WSDOT, County or Municipal road and highway construction projects. This is facilitated by providing products, materials and systems that have previous approval, which in turn saves both manpower and time.

The most current QPL is accessed at the web address that has been used in the past. That website address is <http://www.wsdot.wa.gov/biz/mats/QPL/QPL.cfm>.



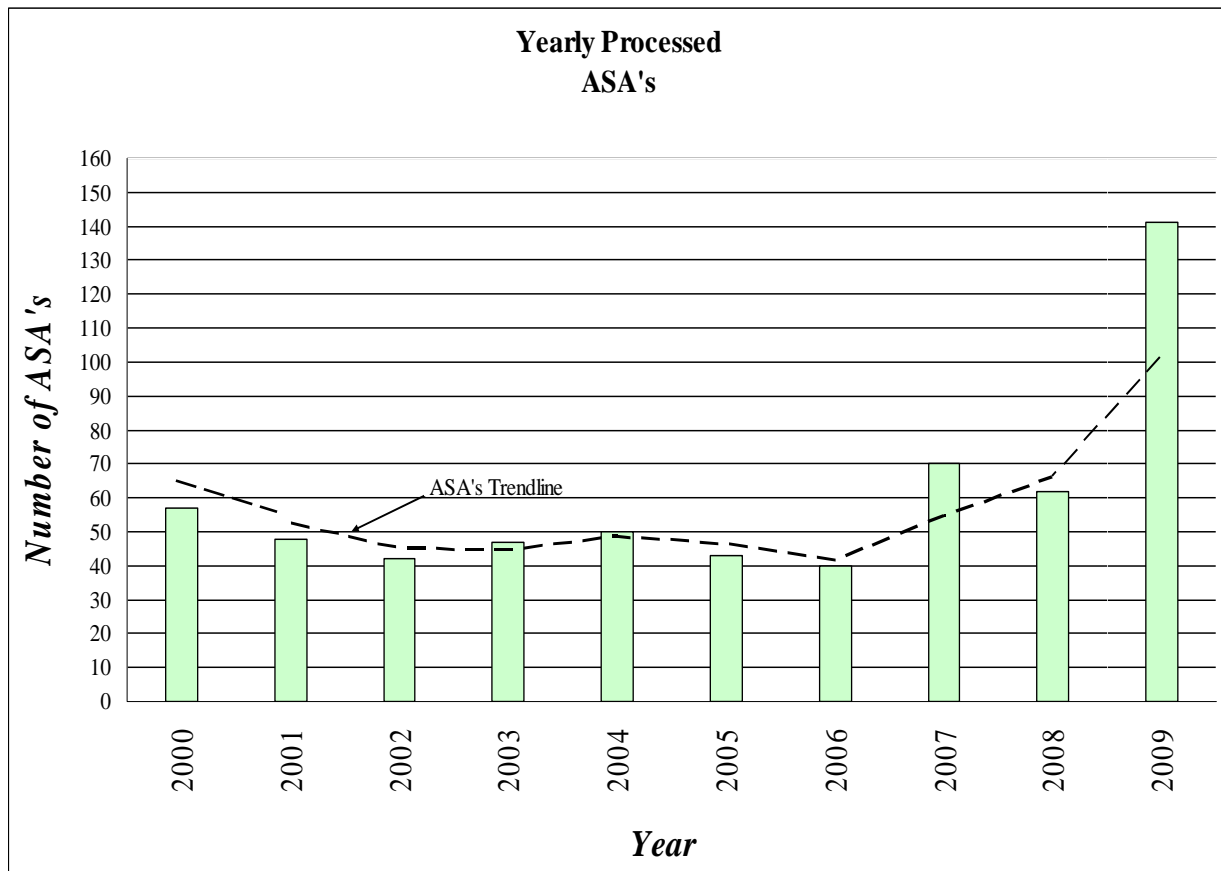
Aggregate Source Approval

The Aggregate Source Approval (ASA) Program is a computer-based program that is used statewide by Contractors, Aggregate Source Owners, Lessees, DNR, Tribes, Local Agencies, WSDOT Regional and Project Personnel. The ASA program determines the approval status of aggregate sources submitted for evaluation for potential use on transportation construction projects.

The sampling of aggregate material sources for evaluation is critically important in the direct support of the highway and local municipality construction programs.

The Aggregate Sources Approval (ASA) application stores the details of Aggregate Sources historically used by contracts in Washington State. The ASA application is designed to allow the user to query the database for only the source or sources that meet the search criteria and also allows examination of each in greater detail.

The Documentation Section's Goal is to be proactive and maintain a reliable database of approved aggregate sources that both governmental and private sector entities have access to for potential use on transportation construction projects.



Compliance Reviews

As part of the WSDOT's Stewardship Agreement with the FHWA, the WSDOT is required to review contract compliance in the materials documentation area, these compliance reviews are a "spot check", verifying compliance with WSDOT's materials documentation requirements. The Materials Documentation Section of the State Materials Laboratory has been tasked with conducting Compliance Reviews and acting as unbiased auditors verifying contracts meet materials documentation requirements.

The requirements are covered in the WSDOT Construction Manual 9-1.2F(2)c, State Materials Laboratory - Compliance Review for Materials Certification Process. A Compliance Review is performed on at least one contract for each project office once every two years. The reason Compliance Reviews are performed is to review previous materials documentation, assist Project Offices in maintaining adequate materials acceptance practices for future contracts, and to be proactive in initiating possible changes to the Construction Manual and Standard Specifications.

The Compliance Review findings are discussed with Project Office personnel during the wrap-up meeting after the review. A final letter covering the compliance review findings is then prepared and shared with WSDOT and the FHWA to document the Compliance Review findings.

Tracking and Charting Compliance Reviews

Each item reviewed during the Compliance Review is evaluated, tracked, and charted in the following areas.

Field Verification

Was the material verified in the field by the inspector for what material was approved to be used by the RAM/QPL and proper acceptance criteria?

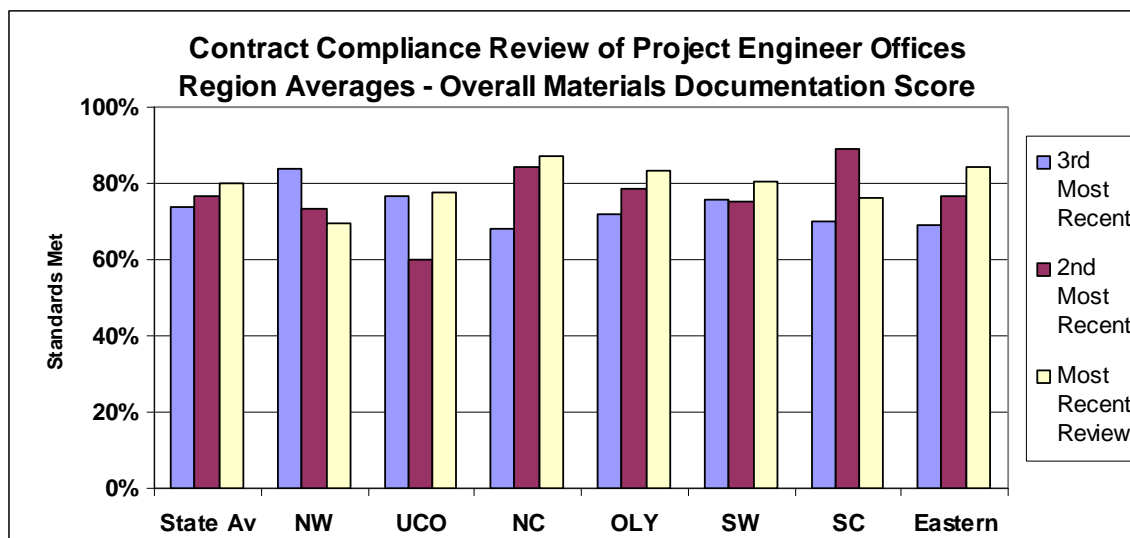
Office Materials Documentation Score

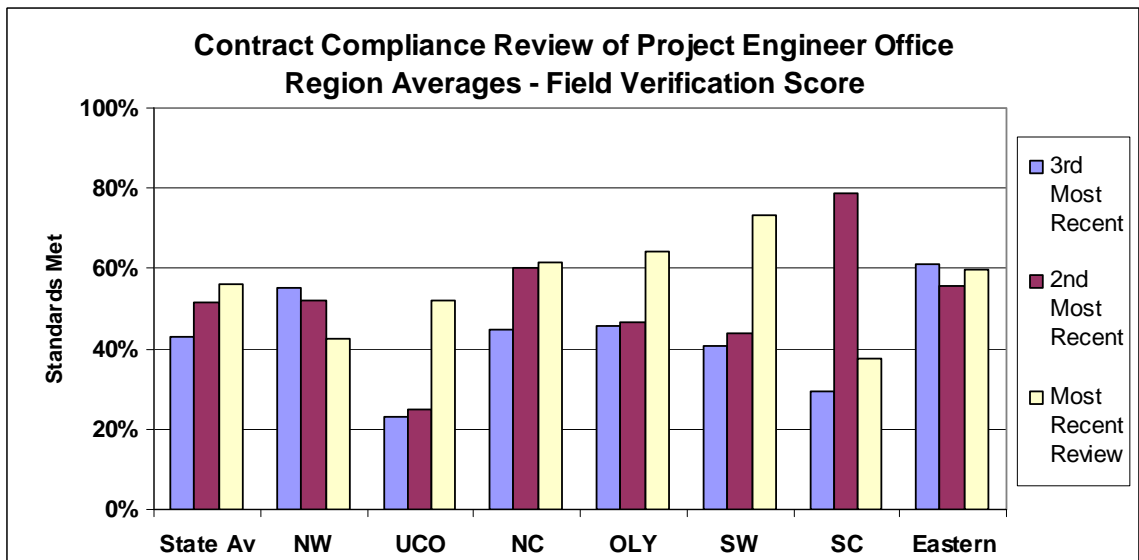
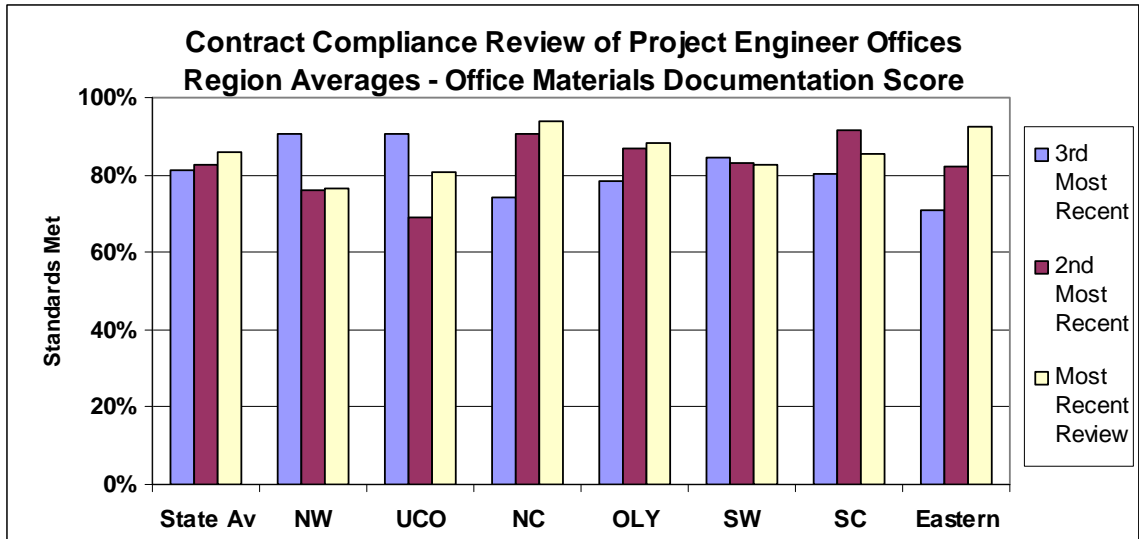
Each criterion mentioned below counts 25% of the Office Materials Documentation Score.

- Were the Pay Ledger and Field Note Records consistent for materials paid?
- Was the maintained ROM (tracking program) being kept up for quantity used, proper materials acceptance, and other documentation requirements as needed per 9-1.5 and 9-1.5A of the Construction Manual?
- Was a RAM or QPL used prior to material placement and used correctly per 1-06.1 of the Standard Specifications and 9-1.5B of the Construction Manual?
- Was the proper acceptance criteria received and approved prior to placement, i.e. Acceptance Sample, Catalog Cut, Manufacture Certification of Compliance, Approved for Shipment 'Tag' or 'Stamp' or Shop Drawing per the Standard Specifications, Standard Plans, Construction Manual and the Contract Specials and Plans?

Overall Materials Documentation Score

The four parts of the Office Materials Documentation Score are added to the Field Verification Score and then divided by "5".





Construction Materials Structural

Fabrication Inspection Section **Crosshole Sonic Logging Testing (CSL)**

The Materials Fabrication Inspection office performs all In-plant inspections for all WSDOT construction contracts for roads and bridges. 13 years ago the fabrication office started providing CSL testing to the Regional Project Engineer's office throughout the State.

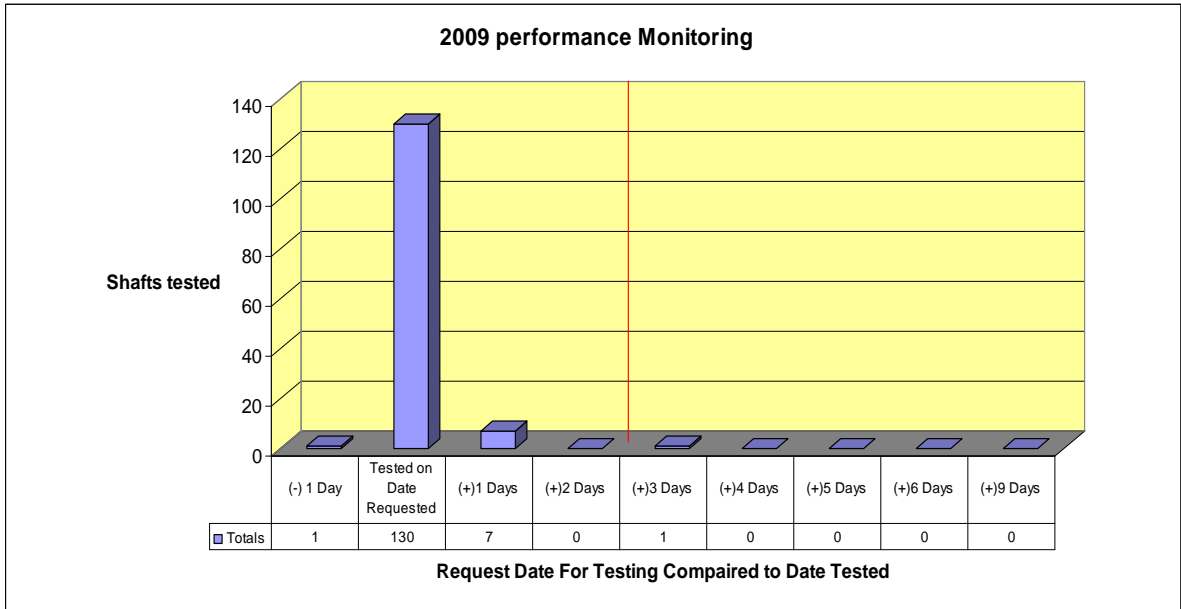
The performance measure will track our response time in performing CSL testing, from the test date requested by the Project Office to the date of actual testing. The goal is to respond no later than 48 business hours from the test date requested.

This information will be used to track our efficiency in responding to the project engineer's office request for CSL testing and also maximizing the scheduling of in-plant inspection of our inspectors.

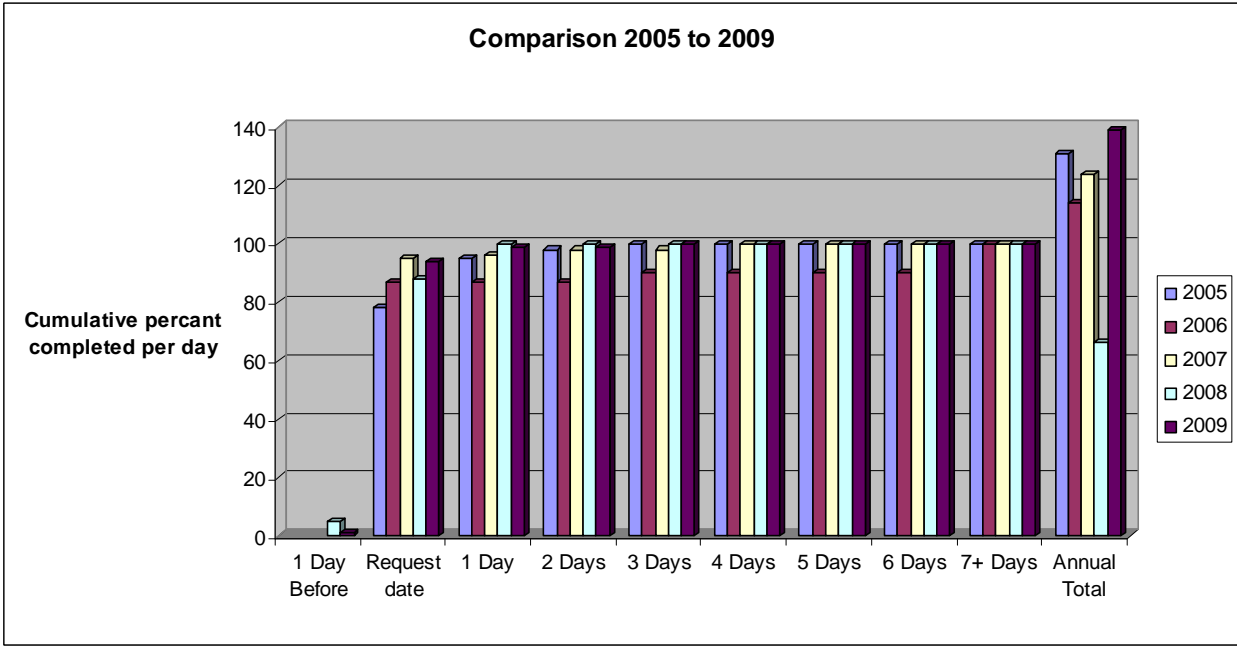
These Performance Measure charts and graphs illustrate the relationship of CSL testing date, as it relates to request dates for CSL testing. They are divided into:

- Notification: Table of number of days from date request for testing until testing with corresponding graph.
- Comparison: Compares cumulative percentage of annual testing from 2005 to 2008, broken down from the request date until actual date tested.

A total of 139 shafts were tested in 2009, of these all were tested within the two day specification except for 1 shaft, which was able to be rescheduled to accommodate workload and staffing between contractor and WSDOT.



The cumulative percentage of the annual total testing by the number of days from the date requested until data acquisition was actually obtained. The target is for 100% of the testing to be completed no later than two days from the request date for testing.



	2005	2006	2007	2008	2009
1 Day Before				5	1
Request date	78	87	95	88	94
1 Day	95	87	96	100	99
2 Days	98	87	98	100	99
3 Days	100	90	98	100	100
4 Days	100	90	100	100	100
5 Days	100	90	100	100	100
6 Days	100	90	100	100	100
7+ Days	100	100	100	100	100
Annual Total	131	114	124	66	139

This year all of the shafts tested were within the 2 Day specification with the exception on 1 shaft, which was able to be rescheduled to accommodate workload and staffing between contractor and WSDOT.

Geotechnical

Productivity Measures

The Geotechnical Division provides statewide geotechnical (foundation engineering and engineering geology) design, construction, and maintenance support services for WSDOT. For performance measurement purposes, The Division's services can be subdivided into three primary functions, which include field exploration services, geotechnical design services, and P3 program unstable slopes technical management.

An important measure of our service to the Region offices, the Marine Division, the Bridge Office, the Office of Program Management, and other key customers statewide is how well we keep our commitments regarding costs and completion time. For geotechnical design, this measure has been accomplished by tracking the number of design hours to complete the geotechnical portion of a project, and comparing that value to the hours estimated for the project. In 2007, however, the performance measure for geotechnical design was switched to design cost. Similarly, for field exploration, tracking the field exploration cost to complete the geotechnical field investigation for a project, and comparing that value to the field exploration cost estimated for the project accomplish this measure.

Another measure of productivity that can be applied to the Field Exploration activities is the cost per foot of test hole drilling. The cost per foot is dependent on a number of factors, including:

- the type of drilling equipment used,
- the travel distance and difficulty encountered in getting the drilling rig to the test hole location,
- the nature of the soil/rock encountered during the drilling (e.g., bouldery soils are much more difficult to drill through than uniform sands and silts), and
- the productiveness of the drill crew.

Therefore, comparisons must be made for similar equipment in similar drilling and access conditions.

Performance measures have been in place for the Geotechnical Division since the latter half of 2001. Since 2006, due to changes in how the Division is tracking geotechnical design projects, the previous years' statistics are not provided. Please refer to previous Materials Lab annual reports for that data. For 2007 through 2009, comparisons between the estimated and actual (billed) costs needed to complete a project geotechnical design are provided in Figure 1. A ratio (costs billed/estimated costs) of 1.0 means that the estimated costs and the billed costs are the same. A ratio less than 1.0 indicates the project was completed at a lower cost than estimated, which is desirable, provided that the estimate was not too much higher than the actual amount it took to get the job completed. A ratio greater than 1.0 indicates that billed costs were greater than estimated, which is undesirable. Our target is to have the estimate within 20% of the actual

costs. If a change in scope for the project occurred after the final estimate was made, the estimate was revised only if the revised estimate was communicated to the region in advance, as soon as the change in scope was known.

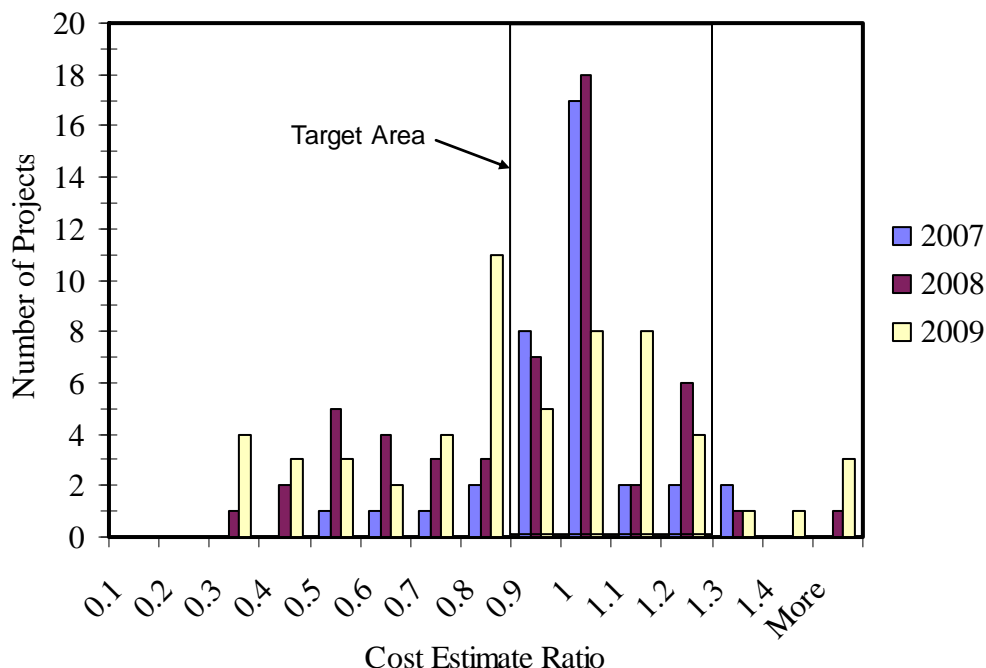


Figure 1. Ratio of billed costs to estimated engineering costs for geotechnical projects completed in 2007 through 2009.

The number of projects that overran the estimate by more than 20% was only 6% of the total for 2007, 4% for 2008, and 9% in 2009. In previous years, based on estimated versus actual (billed) hours, the percent of projects that overran the estimate by more than 20% was typically around 20%. Overall in 2007, the percent of projects that overran or under-ran relative to the estimated project cost by more than 20% was 19%, but in 2008, this increased to 38%, and in 2009 this increased to 56%. In previous years, based on estimated versus actual (billed) hours, the percent of projects that overran or under-ran the estimate by more than 20% was typically around 40%. While a direct comparison to previous years cannot be made, in general the statistics for 2007 appear to be a strong improvement, at least with regard to overrunning project cost estimates. However, these statistics also show that the majority of projects in 2008 and 2009 were significantly overestimated in terms of cost. Apparently, the Geotechnical Division's engineering estimates have been getting a little too conservative. This issue will be further investigated in 2010.

Figure 2 provides a comparison between the estimated and actual (billed) costs needed to complete the field exploration for a design project. A ratio (costs billed/estimated costs) of 1.0 means that the estimated costs and the billed costs are the same. A ratio less than 1.0 indicates the project field exploration was completed for less cost than estimated, which is desirable,

provided that the estimate was not too much higher than the actual amount of time it took to get the job completed. A ratio greater than 1.0 indicates that more cost was billed than estimated, which is undesirable. Our target is to have the estimate within 20% of the actual cost.

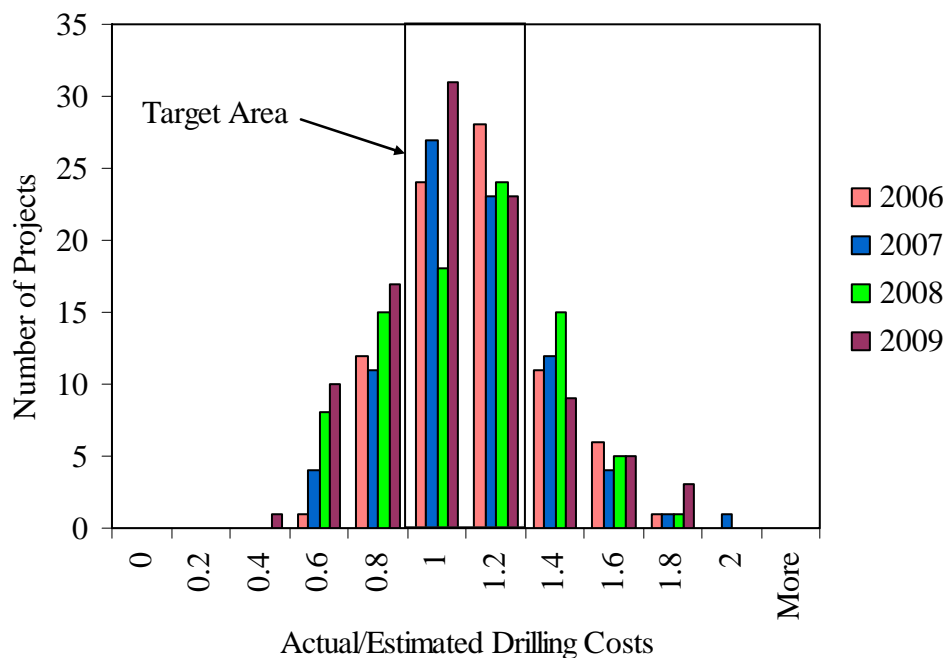


Figure 2. Ratio of billed costs to estimated costs for geotechnical field exploration services completed July 2006 through December 2009.

For the sake of readability, only the data for years 2006 through 2009 are provided. However, Table 1 (below) summarizes the key statistics that illustrate the drilling cost prediction accuracy from 2001 to 2009.

Table 1. Summary of drilling project estimate statistics.

	2001 (last half)	2002	2003	2004	2005	2006	2007	2008	2009
Total Number of Projects	8	74	93	82	71	83	83	86	99
Projects Outside of 20% Target Range (% of total)	38%	39%	37%	37%	32%	37%	40%	51%	45%
Projects More Than 20% Over Budget (% of total)	0%	25%	14%	18%	15%	22%	22%	24%	17%

Figure 3, which shows the difference between the estimated and actual drilling costs for each project, provides a more complete picture of the nature of the overruns in the drilling costs, in that most of the significant overruns are for small projects where a \$5,000 overrun makes a big difference in the ratios. Based on Figure 3, we find that 20% of the field exploration projects were significantly more than \$5,000 over budget (negative numbers indicate a cost overrun) in 2006, 18% in 2007, 26% in 2008, and 16% in 2009. Just an extra day and half of drilling on a project can result in this type of cost increase, which can easily happen depending on the site conditions encountered or if equipment breakdown occurs. This is generally consistent with past years, in which 14% to 20% of the projects were more than \$5,000 over budget. The fluctuation in the number of projects over budget reflects the many uncertainties in estimating the cost of geotechnical field exploration, as discussed in more detail below. Furthermore, this fluctuation is dependent on how aggressively the estimate is made, i.e., rather than estimating project costs conservatively, targeting greater accuracy in the estimate.

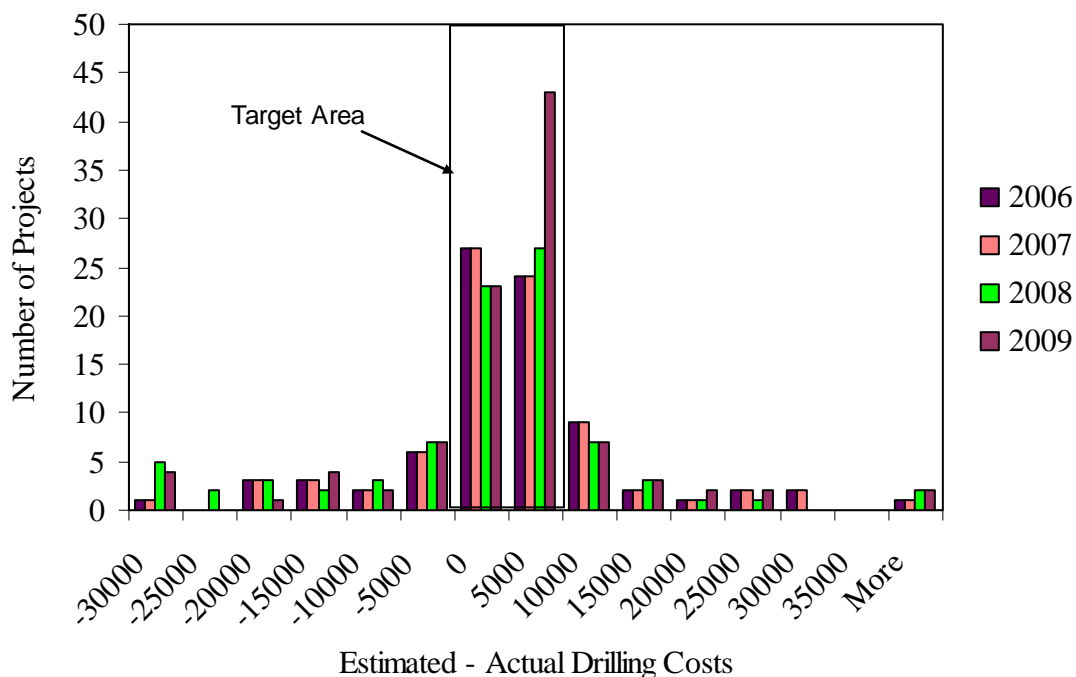


Figure 3. Estimated minus actual cost for geotechnical field exploration services completed January 2006 through December 2009.

It should be recognized that there are a lot of uncertainties in putting together estimates for geotechnical work, primarily due to the variable nature of the subsurface conditions which can affect the type and complexity of the design required, as well as the depth and number of test holes, probes, etc., needed to characterize those conditions. Scope changes during design can also affect the accuracy of the estimate. Continued improvement is needed to better track hours and cost estimates as the project progresses, and to immediately discuss the impact of any customer generated changes in scope with the customer, so that the estimate can be properly adjusted and planned for. We made some progress on this issue in 2008 and 2009, but this will continue to be a goal for next year's performance. Furthermore, when a staff member gets

overwhelmed with a project with complex ground conditions or overall project complexity, there is a tendency for other projects the person is working on to be delayed as well. Tracking these scope changes better and communicating them to the customer as early as possible, as well as attempting to head off the buildup of delayed work earlier through redistribution of work to the staff, will continue to be a focus area in 2010 regarding our project management.

In spite of the uncertainties in estimating geotechnical design and exploration costs, these performance measures have been useful to evaluate performance of crews and units within the Geotechnical Division. These performance measures allow us to monitor crew/unit performance and track project costs better. It has increased our focus on the key aspects of the services provided by the Geotechnical Division. It has also allowed the crew/unit members to see what is expected of them and to follow their progress to completion of all projects. These tools have also proven useful to better communicate with our customers and to help develop realistic expectations regarding the scope and cost of services needed for a given project.

In the past, when criticism has been received, it has often been the result of unrealistic expectations, or poor communication between the Geotechnical Division and the customer regarding the project scope and the cost to accomplish that scope. The performance measures reported herein will continue to be used to insure that the project scope is properly assessed and communicated, and that expectations are realistic.

A benefit of these performance measures is the improved ability of Geotechnical Division managers to evaluate performance and make course corrections before problems get big and costly. This has been especially apparent when evaluating the performance of the field exploration unit. If the performance measures and their use by management are effective, cost decreases to deliver services should occur as inefficiencies are reduced or eliminated. Tables 2, and 3, which provide the unit cost per ft of test hole drilled (field exploration services), illustrate this point:

Table 2. Summary of average drilling costs for 2002 through 2009.

Year	Average Cost/ft for All Rigs	Cost Decrease (-) or Increase (+) Relative to Previous Year
2002	\$124.62	--
2003	\$114.20	-9.1%
2004	\$99.38	-14.9%
2005	\$90.91	-9.3%
2006	\$91.20	+0.3%
2007	\$91.93	+0.8%
2008	\$98.95	+7.1%
2009	\$102.27	+3.3%

Table 3. Summary of average drilling costs, broken out by rig type, for 2008 and 2009.

Type of Drill Rig	Average 2008 Cost/ft of Drill Hole			Average 2009 Cost/ft of Drill Hole		
	No. of Holes	Drill Footage (ft)	Cost/ft	No. of Holes	Drill Footage (ft)	Cost/ft
All Rigs and Projects	994	52,405	\$98.95	910	48,382	\$102.27
Track Mounted 850 Rig	63	3,351	\$116.68	77	3,612	\$90.49
Truck Mounted Rig	14	663	\$108.41	7	205	\$123.06
Skid Rig	36	2,398	\$139.31	95	3,236	\$121.69
Barge Rig	14	1,579	\$166.79	29	2,701	\$205.16
Multiple Rig Type Project	704	37,244	\$116.43	642	36,499	\$109.35
Hand tools	163	7,170	\$6.44	60	2,129	\$17.12

While such comparisons on drilling costs must be made cautiously, as drilling cost for even the same rig type will be affected by the difficulty of the site subsurface conditions, traffic control restrictions, environmental permit restrictions, and variability in the difficulty and distance to mobilize the rig to the site, the general trend is that from 2002 to 2005, a significant decrease in drilling costs occurred each year. These cost decreases occurred in spite of increases during that time period in the cost recovery hourly rates that the Division must charge. These reduced per foot drilling costs have resulted in a total savings of over \$1,000,000 from 2002 through 2005.

Tables 2 and 3 also illustrate another point: that there is a limit in the cost decreases that can be obtained through the use of performance measures. When looking at the 2006 drilling costs per foot, it can be observed that drilling costs per foot did not decrease for the fifth year in a row. From this point forward, what is important is to consistently maintain the reduced cost per foot of drilling. It should also be recognized the recovery rates that must be charged did increase again in 2006 relative to 2005.

A major increase in the cost recovery rates occurred in 2007, primarily due to a significant increase in the base salary for technicians and engineers to catch them up to 25% below their peers in the private sector and other organizations outside of Washington state service. This resulted in an increase of 18% in the cost recovery rates by July 2007. Yet, in spite of this increase in the hourly rates, the overall cost/ft of drilling only increased \$0.73 (0.8%) relative to 2006 costs, illustrating that a significant improvement in the cost effectiveness and efficiency of the WSDOT provided drilling services occurred in 2007. These continued cost decreases relative to the cost recovery rates are an exceptional accomplishment, worthy of recognition.

However, in 2008, the drilling cost per foot increased by \$7.00/ft of drilling, a 7% increase in the drilling cost per foot, and in 2009, by \$3.00/ft of drilling, a 3% increase in the drilling cost per foot. It does appear that the drilling cost drops over the past few years have truly bottomed out. The drilling cost per ft increases that we have observed over the last few years appear to be related to the use of a significant number of non-permanent employees to fill out some of the drill crews in 2008 and 2009, possibly resulting in minor reductions in the productivity of some of the crews due to the limited experience of the non-permanent employees. This was a bigger issue in 2008 than in 2009 as the temporary employees have gained experience. Another issue that appears to be contributing to the cost increase is the need to have an archeologist with the crews as drilling progresses. Coordinating with the archeologist during drilling has been problematic at times as there are sometimes not enough archeologists to go around, resulting in

crews being on standby waiting for one to arrive. The need for an archeologist has become more frequent in the last few years to meet project requirements. The crews are also having to go to more extremes to comply with permit regulations to protect against site runoff issues and protection of adjacent environmental resources. This also increases per ft drilling costs. Finally, the crews have had some unusually difficult drilling projects in 2009 such as the Nile Valley landslide on SR-410, where 500 ft deep holes were needed and drilling conditions were harsh. As discussed in the next section of this report, in spite of this, the WSDOT drill crews are still extremely cost effective.

Comparison to Private Sector

For field exploration services, the drilling cost per foot can reflect the comparative efficiency of the service, provided the comparison is made between drilling projects which are similar in nature regarding the type of equipment used, the depth of the hole, the type of sampling and testing done, the drilling difficulty, and site access difficulty. This cost per foot can be used as the basis of comparison between the private sector and state forces for field exploration services, provided the conditions of project and equipment similarity mentioned previously are met. This generally requires that both the state forces and the private sector contractors be performing work almost side by side on the same project. Note also that comparisons between state forces and the private sector, on a cost per foot basis, must be made for organizations that have a similar ability to provide a variety of exploration services and to adapt to a variety of access conditions. For example, a drilling contractor who only has the ability to drill on the road (i.e., minimal off road access ability) will generally have a lower overhead cost than a contractor who has the ability to access test hole locations in any terrain conditions. The reason for this is the amount of drilling equipment that must be available for use at any time. A full service contractor simply costs more per foot of drilling than a drilling contractor who provides only limited access drilling services. Due to necessity, the Geotechnical Division Field Exploration Unit must have full service ability in all terrain conditions. A fair comparison can only be made to those drilling contractors who provide complete field exploration services at the same level provided by the Geotechnical Division.

Comparisons between state force drilling costs and contractor drilling costs provided in previous Annual Reports for the Materials Laboratory have indicated that state force drilling costs were approximately 70 to 80% of contractor drilling costs, ranging from as low as 46% to as high as just under 100% of contractor drilling costs, at least where such comparisons could be made. While anecdotal, these examples show the cost effectiveness of the state drill crews. In 2009, direct comparisons between WSDOT crews and contract driller crews were not really available, as the contract drillers were typically using different rig types than the WSDOT crews on the same project site.

For engineering services, comparisons to the private sector are more difficult to accomplish, because it is rare that state engineering forces and consultant engineering forces are working side-by-side doing similar tasks. Differences between the WSDOT Geotechnical Division and geotechnical consultants in the cost of geotechnical design services is the result of both hourly rate differences and differences in the hours a consultant may charge for a set of tasks versus the hours the Geotechnical Division would charge for the same set of tasks. A comparison

conducted in 2008, reported in the 2008 Materials lab Annual Report, indicated that on average, based on recent consultant task assignments, consultant rates are 37% higher than WSDOT hourly rates. New comparisons for 2009 were not conducted.

The more difficult comparison to make is in the number of ours charged to complete the tasks associated with a given project. While this comparison could be based on man-hour estimates made by the state and by the consultant independently, such estimates could be well off of what is really needed. However, the tendency is that consultant estimates are significantly higher than what the state would estimate to complete the project. Examples from 2008 were reported in the 2008 Materials Lab Annual Report. See that annual report for details.

Geotechnical laboratory testing is typically charged by the test. A detailed comparison to testing costs charged by geotechnical consultants was provided in the 2008 Materials Lab Annual Report – see that report for details. In general, WSDOT geotechnical testing costs charged are considerably less than what is charged by consultants for the same service. On average, with the exception of fine grading, consultant geotechnical laboratory testing costs are 26 to 200% higher than the WSDOT geotechnical laboratory testing costs charged. For fine grading, WSDOT and consultant testing costs are about the same. New comparisons in 2009 were not conducted.

Significant Programmatic Accomplishments for the Geotechnical Division in 2009

WSDOT Geotechnical Design Manual

Since its publication in September 2005, the Geotechnical Design Manual (GDM) has been in high demand from consultants, regionally and even nationally, and other state DOT's are looking to the WSDOT GDM as the basis for developing their own geotechnical design manuals, and in some cases, using it verbatim. Furthermore, the FHWA continues to promote the WSDOT GDM on their geotechnical website as a model for other state DOT's to follow.

Updates to GDM Chapters 1, 2, 3, 5, 6, 7, 8, 9, and 23 were completed in 2009. The update to Chapter 1 included improved guidance to the Region Materials Labs regarding what is defined as soft or unstable ground where HQ geotechnical assistance is needed, and guidance on division of responsibilities for geotechnical construction support. Some of the chapter changes were fairly minor (chapters 2, 3, 5 and 23), whereas the changes in the other chapters were more significant, added in part to close gaps in the design requirements used by design-builders. The update to Chapter 6 included improved guidance on use of ground improvement to deal with liquefaction problems, and guidance on the pitfalls that needed to be addressed when performing site specific ground response analyses using effective stress nonlinear computer models. The update to Chapter 7 included guidance on the use of translational (sliding block) failure surfaces for slope stability analysis, especially when significantly different soil units are next to each other, has been added. The update to Chapter 8 included the addition of down drag load factors for the case where some of the down drag load is caused by settlement of an overlying sand layer, the removal of design equations for soils classified as intermediate geo-materials (as we discovered

that those design equations were excessively conservative), improved guidance on how to design shafts for lateral resistance in rock (lack of guidance in this area caused some problems with the design of some recent projects), and clarification of the soil loading diagrams for bridge abutments. The update to Chapter 9 included additional guidance on designing for embankment settlement, additional guidance on addressing compaction and stability of the embankment slope face, plus a discussion of maximum acceptable fill slopes and related considerations. These issues came up in a design-build project where the design-builder was too aggressive with using fill slopes that were too steep which could result in long-term maintenance problems for WSDOT.

This manual has helped to define geotechnical design policies that in the past were nebulous and inconsistent in their implementation (e.g., liquefaction mitigation) and has made RFP's for design-build projects much more clear regarding WSDOT's desired geotechnical design requirements. This manual will remain a living document, enabling it to be adjusted and improved as design issues occur, and also provides a great place to implement geotechnical research results as they become available and proven.

LRFD Design Specification Implementation for Foundations and Walls

As indicated in previous annual reports, we have actively assisted the AASHTO Bridge Subcommittee and the FHWA to accomplish a rewrite of the foundation design sections in 2004 and 2005, as well as to gain the national acceptance needed in the AASHTO Bridge Subcommittee to get the rewrite approved. We also helped to develop the load and resistance factors used for LRFD foundation and wall design. The load and resistance factors are in effect safety factors, and directly affect how conservative, and therefore how costly, the resulting design will be. Work to continue the effort to improve the LRFD design specifications continued through 2009, including completion of additional changes to the pile foundation design specifications, geotechnical load and resistance factor development, and initial efforts to rewrite and update the seismic design provisions for walls. Several Geotechnical Division staff have continued to participate on NCHRP panels that have been set up to oversee research on load and resistance factor development for foundations and walls, specifically footing strength limit state design and service limit state design for foundations in general). It is our goal to keep the foundations and walls that we design as economically efficient as possible while providing a consistent level of reliability for the performance of these types of structures.

Implementation of this work has been, or is being, accomplished through updates to the WSDOT GDM and the WSDOT Standard Plans. The final draft of the Standard Plans for geosynthetic walls (D-3) was also completed in 2009. This is a final step in the implementation of LRFD, and the new AASHTO specifications, for walls.

MSE Retaining Wall Research

Since 1990, WSDOT, with the help of a number of public and private sector funding partners, the University of Washington, and the Royal Military College of Canada, has conducted research on the internal stability of mechanically stabilized earth (MSE) walls. MSE walls are commonly used by WSDOT in situations where fill must be added to the roadway prism for widening of the roadway. Our early experience with these walls, and the experiences of others, has indicated that

current design procedures are conservative, especially for geosynthetic reinforced systems. We felt that if we could develop a more accurate procedure for estimating reinforcement loads in these walls, substantial cost savings for WSDOT (and nationally as well) could be obtained.

From this research, a new design method for the internal stability of MSE walls termed the K-Stiffness Method has been developed, as reported in previous Annual Reports. The new method appears to provide the ability to significantly reduce the amount of soil reinforcement required due to the greater accuracy and reliability of the method, with potential significant cost savings for these types of retaining walls. The work has been published in international journals and conferences, and is receiving praise worldwide as a major breakthrough for the design of these types of wall systems. We have begun implementation of the research completed thus far through construction and monitoring of some test walls on SR-18 that have been reported in the 2005 annual report. We have also provided step-by-step design procedures for this new method in the WSDOT GDM.

This research project is nearing completion, with an estimated completion date of December 31, 2010. The final test wall has been completed and is in the final stages of testing.

Electronic Preservation of Geotechnical Design and Construction Files

The paper files that contain geotechnical subsurface data, design, and construction records is in effect a significant and important database of geotechnical information that has cost millions of dollars to produce over the years. This information is used routinely for geotechnical design of projects both by in-house staff and consultants and is a very valuable resource. The preservation of these files electronically is strategic for the department both to protect this significant investment and make access to this information easier for those involved in geotechnical design as well as related fields. The database structure, and the detailed procedures for file organization and the scanning/recording process were developed in 2006. Staff to do this work were hired, the scanning equipment obtained, and a majority of the files have been scanned. This work is continuing.

Developing GIS as a Geotechnical Design Tool

GIS was used extensively by the Geotechnical; Division in 2009 to provide mapping, analysis and data management support on geotechnical engineering design projects. The Geotechnical Workbench project to develop spatial data and tools to support GIS mapping and analysis was also completed and deployed. Standards for data collection and management were developed to improve the integrity and availability of geotechnical data and documentation in the future.

A Scope of Work has been developed to support the development of a Geotechnical Database Management System (GDBMS) what will improve the management of geotechnical data and data delivery. The GDBMS establishes strategies for managing geotechnical data, and a key feature will be the ability to spatially locate geotechnical boring logs. However, due to loss of some of our GIS staff and lack of funding, the database work has been put on hold.

Proposed Programmatic Accomplishments for 2010

The programmatic accomplishments proposed for 2010 are as described in the Materials Lab (Geotechnical Division) Strategic Directions. Additional information regarding some of the strategic directions is as follows:

LRFD Design Specification Implementation for Foundations and Walls

Continued development of the AASHTO LRFD Bridge Design Specifications regarding foundation and wall design is anticipated in 2010. Specifically, we anticipate beginning implementation of improved shaft design procedures and resistance factors from a newly developed FHWA manual on drilled shafts, development of improved specifications for the seismic design of walls, development of new resistance factors for service limit state design of foundations (i.e., settlement, lateral deformation), and possibly beginning the development of LRFD design specifications for soil nail walls.

MSE Retaining Wall Research

The research on MSE walls will continue through the end of 2010, providing refinement of the K-Stiffness Method, and broadening its applicability to poorer quality backfill materials as high quality backfill materials continue to become more scarce, and also integrating it with other aspects of MSE wall design (e.g., seismic design, abutment loads, limit equilibrium compound stability analysis, etc.). We will continue to combine our efforts with the Japanese to incorporate their wall data using lower quality fill materials with our own efforts. We hope to take advantage of any new walls constructed using the K-Stiffness method to verify the accuracy of that method. These field design method verification walls are critical to the implementation of this research, as well as the extension of this new method to poorer quality soils and other loading situations such as seismic. Calibration of this method to determine appropriate load and resistance factors is underway and will be continued so that the K-Stiffness Method is ready for use in the AASHTO LRFD design specifications. We will also continue to work with the AASHTO Bridge Subcommittee to continue the implementation process for this new design method in the AASHTO LRFD design specifications, once the K-Stiffness Method research is completed.

Update WSDOT Geotechnical Design Manual (GDM)

It is recognized that the GDM needs to remain a living document to keep up to date with the latest developments, but that changes to the manual should not be made frequently. Our goal is to update the manual once per year, unless an urgent need is discovered that warrants correcting sooner. Furthermore, some chapters in the GDM were not fully developed. Updates planned in 2010 include Chapter 15 (walls), including several of the Chapter 15 appendices, as well as minor changes in several other chapters.

Electronic Preservation of Geotechnical Design and Construction Files

File scanning will continue and hopefully be completed, but subject to availability of funding.

Pavements

Pavement Management Section Pavement Condition Trend

This performance measure documents the statewide pavement condition as represented by the pavement structural condition (cracking, faulting, patching, etc.), rutting and ride (smoothness) measurements on the state highway network. This measure includes all pavement types, chip seal, asphalt, and concrete. These condition measures are used to characterize each pavement section in to one of five categories: very good, good, fair, poor, and very poor. A pavement section is determined to be “due” for rehabilitation when it has reached the “Fair” category based on one or more condition measures. The chart illustrates the number of lane miles of pavement in each of the five categories from 1997 to 2008 for the approximately 17,500 lanes miles of state route system. WSDOT’s goal is to reach approximately 1,700 lane miles of pavement in the “Fair” category and none¹ in the “Poor” or “Very Poor” category. Since last reporting in January 2009, the 2008 condition data (rated and analyzed during 2008-2009) has been added and shows that the poor pavement (“Poor” and “Very Poor” categories) has decreased by about 240 lane miles (1.3% of the state system).

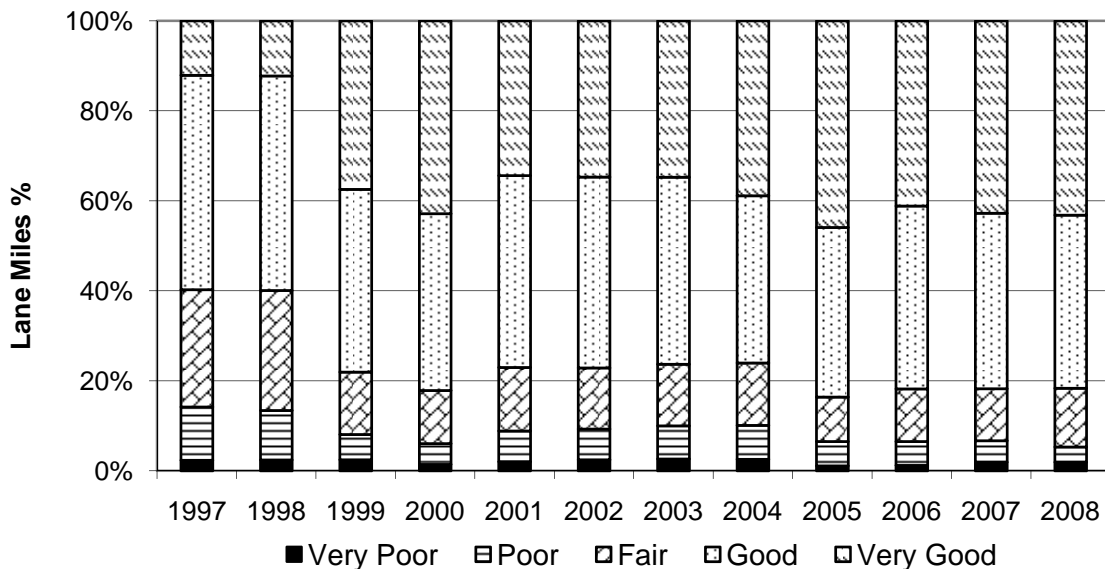


Figure 1: Pavement Condition

¹ Except for those sections of pavements that are intentionally delayed due to upcoming reconstruction or other major construction work.

The following table represents the above figure and illustrates the number of good (pavements in very good, good and fair condition) and poor (pavements in poor and very poor condition) lane miles for all pavement types.

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Good (lane miles)	15197	15383	16354	16516	16186	16197	15916	15965	16617	16743	16160	16403
Poor (lane miles)	2515	2387	1441	1068	1578	1659	1787	1797	1162	1153	1162	922

QA/QC in Pavement Rating

This performance measure attempts to quantify the accuracy of annual pavement condition surveys using statistical methods. One of the concerns WSPMS users have raised in the past has been that, in some cases, the survey results do not accurately reflect the condition of the pavement section. After the rating crew has finished rating a “set” (approximately 100 miles of roadway), about five random sample sections, each approximately 1 mile long, are selected within this set and are rated again (“sample” rating) by a different rather than the one who performed the “production” rating. The Pavement Structural Condition (PSC), a combined index of the various distresses on the pavement surface, is then computed using both the “production” rating and the “sample” rating and are then compared for any statistical differences. For the 2008-2009 pavement rating, 504 sample sections (each approximately 1 mile long) out of a total of approximately 8,600 miles of rated roadway were considered. The “production” and “sample” ratings were tested for differences using paired t-test and Wilcoxon signed rank test and both tests indicated that there are no significant differences between the two ratings.

The following two figures show graphically the differences between the “production” and “sample” rating. Out of the 564 sample sections considered, 544 sections (96.5%) had a PSC difference of less than 10 points and 20 sections (3.5%) had a PSC difference of more 10 than points. In Figure 2, the solid line represents the line of equality ($R^2 = 84.4\%$) and the dashed lines represent ± 10 PSC points difference.

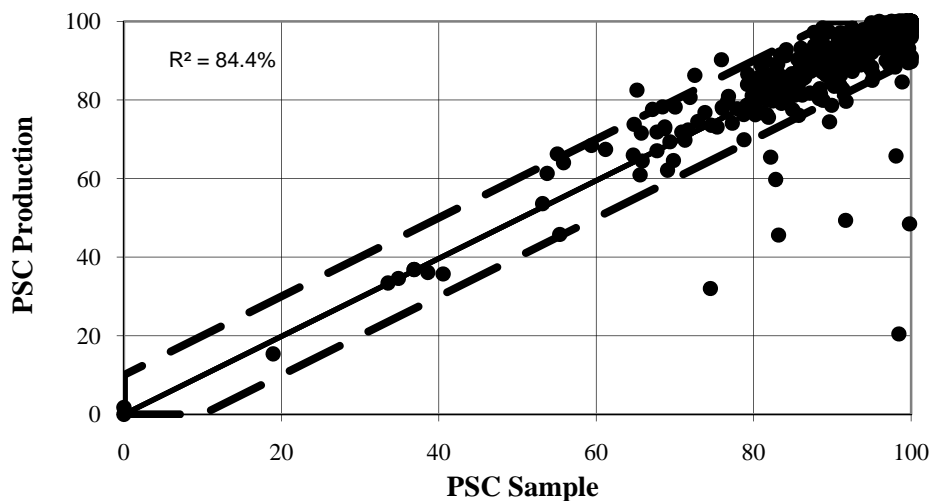


Figure 2: PSC Comparison

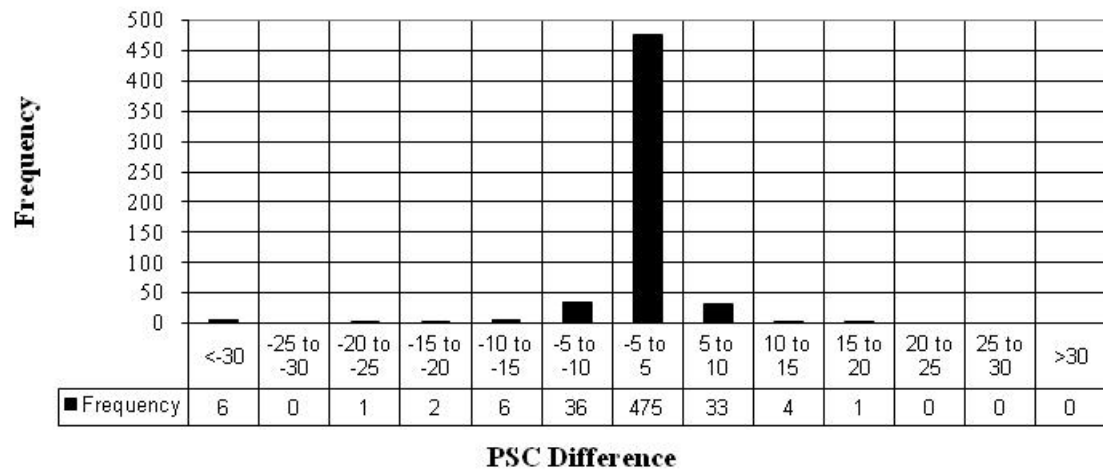


Figure 3: Histogram of Differences in PSC between Production and Sample Rating

Pavements –Review of Region Pavement Rehabilitation Reports

This performance measure documents the number of days to review, analyze, and concur with Region Rehabilitation Reports. The target for rehabilitation report concurrence is 20 days. Twenty days was set as a target for 2008 and again in 2009. The average time required to review rehabilitation reports for 2008 was 6 days. The average time required to review rehabilitation reports for 2009 was 3 days. On occasion, the target of 20 days was exceeded, however, this was often the result of obtaining additional information from the Region or other data needed to review the reports.

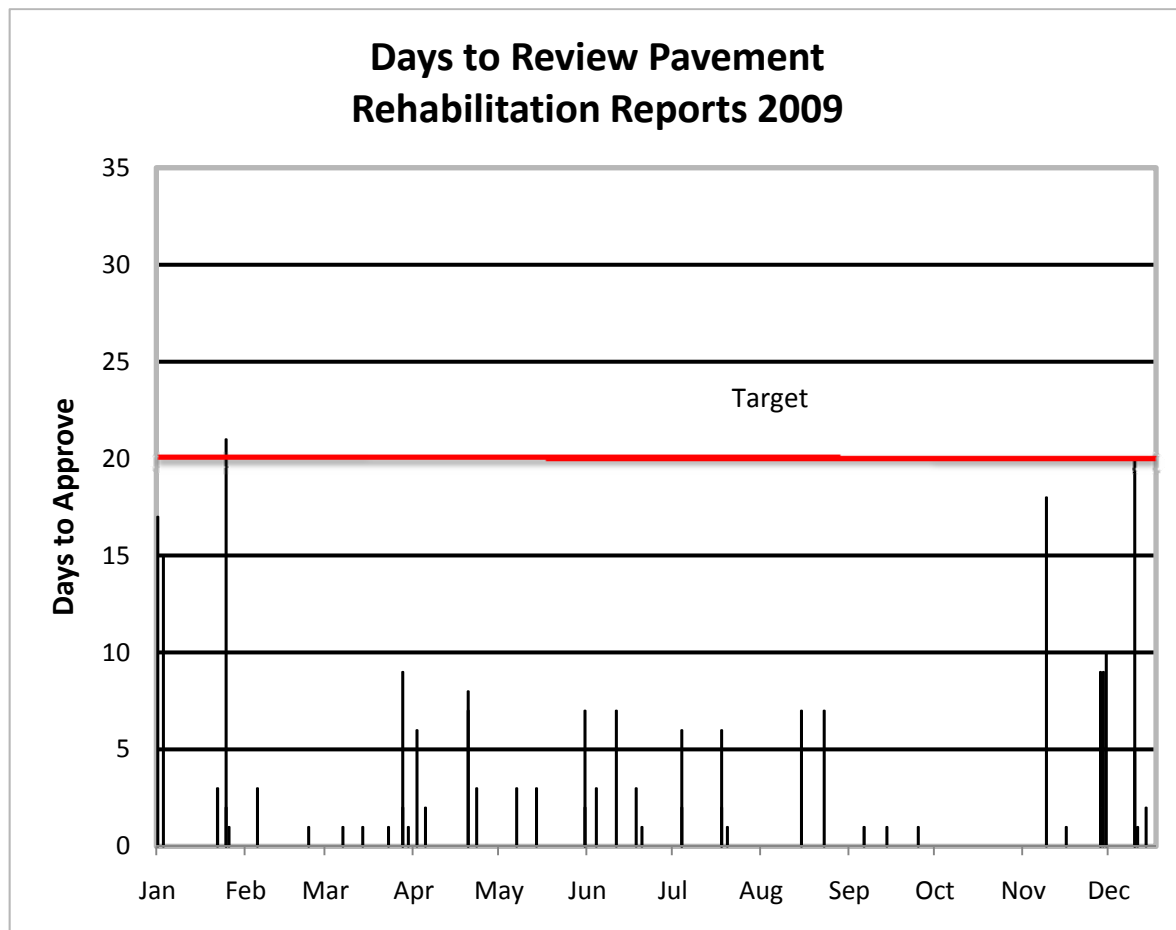


Figure 1. Days Required to Review Pavement Rehabilitation Reports for 2009.

Administrative

IT Support Help Desk Response Time

The Materials Laboratory IT Support categorize requests according to the following five major areas: Workstation (hardware, software, etc.); Printing (copier, printer, label maker, etc.); Network (hardware, software, etc.); Services (data backup, internet or intranet, loaner, research and development, etc.); Account Services (domain, e-mail, RAS, etc.).

The following graphs illustrate the average completion time for all IT help requests in the five mentioned categories. Categories, such as development, are not included in this performance measure since the Materials Laboratory IT Support does not have direct control over this function. In addition, the analysis has excluded all requests that require the acquisition of either hardware or software, since in many cases this may require several days to several weeks for the acquisition and shipment.

Total Requests in 2009 – 3106

